10-3930-633-34

TM 10-3930-633-34

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

TECHNICAL MANUAL

DIRECT SUPPORT, AND GENERAL SUPPORT

MAINTENANCE MANUAL

TRACTOR, WHEELED, WAREHOUSE GASOLINE, 4-WHEEL PNEUMATIC TIRED, 4000 POUND DRAWBAR PULL

(ARMY MODEL MHE-228)

(CLARK EQUIPMENT MODEL 2330237)

NSN 3930-00-347-6173

HEADQUARTERS, DEPARTMENT OF THE ARMY

MARCH 1975

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WARNING

Hydrogen, an explosive gas, is generated by battery.

DEATH

or severe injury may result if personnel smoke when servicing battery, or if there is flame in the vicinity.

WARNING

Carbon monoxide, a poisonous gas, is produced by gasoline engines.

DEATH

or severe injury may result if vehicle is operated in an unventilated area.

WARNING

Operation of this equipment presents a noise hazard to personnel in the area. The noise exceeds the allowable limits for unprotected personnel. Wear ear muffs or ear plugs which were fitted by a trained professional.

WARNING

DEATH

or severe injury may result if personnel fail to observe the following precautions:

Do not fill tank while engine is running. Provide metallic contact between the fuel container and fuel tank to prevent a static spark from igniting fuel. Wipe or flush any spillage.

Be cautious during operation, when approaching doorways, aisles, intersections or other workers.

Avoid sudden starting and stopping. Reduce speed on turns.

Know the rated capacity of the truck and do not overload it.

Immediately remove from service any vehicle showing a defect or malfunction which might prove hazardous to operating personnel or cause further damage to equipment.

Do not remove radiator cap from an overheated radiator. Stop engine and allow radiator to cool before removing cap to avoid injury by scalding.

If vehicle is parked on an incline, set brakes and block at least 2 wheels as a precaution against hand brake failure.

TECHNICAL MANUAL
No. 10-3930-633-34

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, D.C., *7 March 1975*

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE MANUAL

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			Paragraph	Page
CHAPTER	1.	INTRODUCTION		
Section	I.	General	1-1	1-1
	II.	Description and Data	1-7	1-1
CHAPTER	2.	DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS		
Section	I.	Repair Parts, Special Tools and Equipment	2-1	2-1
	II.	Troubleshooting	2-3	2-1
	III.	General Maintenance	2-4	2-7
	IV.	Removal and Installation of Major Components and Assemblies	2-23	2-12
CHAPTER	3.	REPAIR OF ELECTRICAL SYSTEM		
Section	I.	Alternator	3-1	3-1
	II.	Starter	3-5	3-6
	III.	Ignition Distributor	3-7	3-9
CHAPTER	4.	REPAIR OF FUEL SYSTEM	4-1	4-1
	5.	REPAIR OF COOLING SYSTEM	5-1	5-1
	6.	REPAIR OF ENGINE		
Section	I.	Description	6-1	6-1
	II.	Engine Test and Performance Analysis	6-6	6-2
	III.	Engine Overhaul	6-9	6-4
	IV.	Cylinder Head and Valves	6-13	6-13
	V.	Cylinder Block	6-22	6-21
	VI.	Pistons, Pins and Rings	6-26	6-23
	VII.	Connecting Rod and Crankshaft	6-29	6-28
	VIII.	Camshaft and Timing Gears	6-37	6-36
	IX.	Oil Pan and Oil Pump	6-42	6-41
CHAPTER	7.	REPAIR OF TRANSMISSION		
Section	I.	Description	7-1	7-1
	II.	Adjustments and Tests	7-4	7-5
	III.	Transmission Repairs	7-10	7-9
CHATPER	8.	REPAIR OF PROPELLER SHAFT	8-1	8-1
CHAPTER	9.	REPAIR OF WHEELS AND BRAKES		
Section	I.	Wheels and Tires	9-1	9-1
	II.	Brake System	9-5	9-2

			Paragraph	Page
CHAPTER	10.	REPAIR OF REAR AXLE AND SPRINGS	10-1	10-1
	11.	REPAIR OF STEERING SYSTEM	11-1	11-1
	12.	REPAIR OF FRONT AXLE AND SPRINGS	12-1	12-1
APPENDIX	A.	REFERENCES		A-1
INDEX				I-1

LIST OF ILLUSTRATIONS

Fig. No.	*Title*	*Page*
1-1.	Wheeled Warehouse Tractor	1-2
2-1.	Preparation for Engine Removal	2-13
2-2.	Engine Front Support	2-14
2-3.	Transmission Mounting	2-15
2-4.	Rear Axle Removal	2-17
2-5.	Front Axle Removal	2-18
2-6.	Vacuum Power Unit Installation	2-19
2-7.	Steering Gear Mounting	2-19
3-1.	Alternator Assembly	3-2
3-2.	Rotor Checks	3-3
3-3.	Brush Holder Assembly	3-5
3-4.	Heat Sink	3-5
3-5.	Starter Assembly	3-7
3-6.	Testing for Shorts	3-8
3-7.	Testing for Grounds	3-9
3-8.	Distributor Cutaway	3-10
3-9.	Distributor Assembly	3-11
4-1.	Fuel System	4-2
4-2.	Carburetor Installed	4-3
4-3.	Carburetor Assembly Exploded View	4-4
4-4.	Pump Adjustment	4-6
6-1.	Manifold Vacuum Test Connection	6-2
6-2.	Engine Assembly	6-5
6-3.	Engine on Work Stand	6-6
6-4.	Cylinder Block Assembly	6-7
6-5.	Camshaft and Valve Train	6-8
6-6.	Valve Lifter Removal	6-9
6-7.	Crankshaft and Pistons	6-10
6-8.	Compressing Valve Spring	6-13
6-9.	Valve Parts	6-14
6-10.	Checking Valve Seat Runout	6-14
6-11.	Checking Valve Seat Width	6-15
6-12.	Reaming Rocker Arm Stud Bore	6-15
6-13.	Installing New Rocker Arm Studs	6-16
6-14.	Reaming Valve Guides	6-16
6-15.	Valve Seat Refacing	6-17
6-16.	Valve Inspection	6-17
6-17.	Checking Valve Stem Clearance	6-18
6-18.	Checking Valve Spring Pressure	6-18
6-19.	Checking Valve Spring Squareness	6-19
6-20.	Checking Pushrod Straightness	6-19
6-21.	Testing Hydraulic Lifter	6-20
6-22.	Checking Valve Spring Height	6-21
6-23.	Checking Cylinder Bores	6-22
6-24.	Core Plug Installation	6-23
6-25.	Cleaning Ring Grooves	6-24
6-26.	Checking Ring Gap	6-25
6-27.	Checking Ring Side Clearance	6-25
6-28.	Piston and Connecting Rod Assembly	6-26
6-29.	Oil Hole Position	6-26
6-30.	Installing Piston Pin	6-26
6-31.	Piston Ring Gap Spacing	6-27
6-32.	Piston Installation	6-27
6-33.	Checking Rod Side Clearance	6-27
6-34.	Crankshaft and Related Parts	6-28
6-35.	Removing Crankshaft Damper	6-28
6-36.	Timing Gear Aligning Marks	6-29
6-37.	Removing Crankshaft Gear	6-29
6-38.	Aligning Thrust Bearings	6-30
6-39.	Installing Crankshaft Rear Seal	6-31
6-40.	Installing Crankshaft Front Oil Seal	6-31
6-41.	Installing Oil Pan Rear Seal	6-31
6-42.	Oil Pan Gaskets and Seal	6-32
6-43.	Journal Measurements	6-32

LIST OF ILLUSTRATIONS—Continued

Fig. No.	*Title*	*Page*
6-44.	Typical Bearing Failures	6-33
6-45.	Fitting Bearings with Plastigage	6-34
6-46.	Checking Crankshaft End Play	6-34
6-47.	Aligning Cylinder Front Cover	6-35
6-48.	Installing Crankshaft Damper	6-36
6-49.	Camshaft and Related Parts	6-36
6-50.	Checking Camshaft End Play	6-37
6-51.	Checking Timing Gear Backlash	6-37
6-52.	Checking Timing Gear Runout	6-38
6-53.	Thrust Plate Screws	6-38
6-54.	Removing Camshaft Gear	6-38
6-55.	Installing Camshaft Gear	6-39
6-56.	Checking Camshaft Lobe Life	5-40
6-57.	Oil Pump Installed	6-41
6-58.	Oil Pump Disassembled	6-41
6-59.	Measuring Outer Race Clearance	6-42
6-60.	Measuring Rotor End Play	6-42
7-1.	Transmission Cutaway	7-1
7-2.	Hydraulic Control System	7-3
7-3.	Front Band Adjustment	7-5
7-4.	Rear Band Adjustment	7-6
7-5.	Control Pressure Port	7-7
7-6.	Air Pressure Checks	7-8
7-7.	Transmission Assembly	7-10
7-8.	Extension Housing Parts	7-12
7-9.	Output Shaft and Rear Pump	7-13
7-10.	Input Shaft and Clutch	7-13
7-11.	Input Shaft and Clutch Removal	7-13
7-12.	Planetary Clutch, Carrier and Center Support	7-14
7-13.	Planetary Clutch Installation	7-15
7-14.	Control Valve Body Installed	7-16
7-15.	Control Valve Body	7-18
7-16.	Check Valve Locations	7-19
7-17.	Front Servo	7-20
7-18.	Rear Servo	7-22
7-19.	Extension Housing Bearing Removal	7-23
7-20.	Installing Extension Housing Seal	7-23
7-21.	Governor Installed	7-23
7-22.	Governor Parts	7-24
7-23.	Pressure Regulator Parts	7-24
7-24.	Manual Linkage	7-25
7-25.	Front Pump	7-26
7-26.	Removing Front Pump Seal	7-26
7-27.	Installing Front Pump Seal	7-27
7-28.	Removing Snap Ring	7-27
7-29.	Removing Front Clutch Snap Ring	7-28
7-30.	Removing Piston	7-29
7-31.	Clutch Piston Check Ball	7-29
7-32.	Installing Front Clutch Hub	7-30
7-33.	Installing Pressure Plate	7-31
7-34.	Installing Clutch Plates	7-31
7-35.	Primary Sun Gear Shaft	7-32
8-1.	Propeller Shaft Assembly	8-2
9-1.	Wheel Removal	9-2
9-2.	Front Brake Assembly	9-3
9-3.	Rear Brake Assembly	9-4
9-4.	Vacuum Power Unit	9-6
9-5.	Vacuum Power Unit Cross Section	9-7
9-6.	Vacuum Power Unit Exploded View	9-8
9-7.	Removing Valve Rod	9-9
9-8.	Separating Front and Rear Shells	9-10
9-9.	Installing Vacuum Seal	9-11
9-10.	Adjusting Pushrod	9-12
10-1.	Rear Axle Assembly	10-1
10-2.	Loosening Axle Shaft Flange	10-2

LIST OF ILLUSTRATIONS—Continued

Fig. No.	*Title*	*Page*
10-3.	Removing Axle Shaft	10-2
10-4.	Removing Hub and Drum Assembly	10-2
10-5.	Drop Gear Case	10-3
10-6.	Differential Carrier Assembly	10-5
10-7.	Match Marking	10-6
10-8.	Differential Removal	10-6
10-9.	Differential Bearing Removal	10-6
10-10.	Installing Differential Bearing Caps	10-7
11-1.	Steering System	11-1
11-2.	Tie Rod Adjustment	11-2
11-3.	Steering Gear and Column	11-3
11-4.	Lash Adjuster Clearance	11-4
12-1.	Front Axle Installation	12-1
12-2.	Front Axle Assembly	12-2

LIST OF TABLES

Table No.	*Title*	*Page*
2-1.	Troubleshooting	2-1
6-1.	Manifold Vacuum Readings	6-3
6-2.	Compression Test Pressure Limits	6-3
6-3.	Engine Fasteners Torque Values	6-11
6-4.	Valve Spring Specifications	6-19
6-5.	Piston, Pin, and Ring Fits	6-24
6-6.	Crankshaft, Connecting Rod, and Bearing Specifications	6-30
6-7.	Camshaft and Timing Gear Specifications	6-37
7-1.	Clutch Applications	7-2
7-2.	Control Pressure Checks	7-7
7-3.	Abnormal Pressure Reading Diagnosis	7-7

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1-1. Scope

This manual is for use by direct support and general support maintenance personnel, in maintaining the Army Model MHE-228 Warehouse Tractor.

1-2. Maintenance Forms and Records

Maintenance forms and records that you are required to use are explained in TM 38-750.

1-3. Reporting of Errors

You can help to improve this manual by calling attention to errors and by recommending improvements. Your letter, DA Form 2028 (Recommended Changes to Publications), and/or DA Form 2028-2 (Recommended Changes to Equipment Technical Manuals), may be used. Copies of DA Form 2028-2 are attached in the back of the manual for your use. Please mail your recommended changes directly to Commander, U.S. Army Troop Support Command, ATTN: AMSTS-MPP, 4300 Goodfellow Blvd., St. Louis, MO 63120. A reply will be furnished directly to you.

1-4. Equipment Serviceability Criteria (ESC)

This equipment is not covered by an ESC.

1-5. Destruction of Army Materiel to Prevent Enemy Use

Refer to TM 750-244-3 for procedures covering destruction of this vehicle to prevent enemy use.

1-6. Administrative Storage

Preparation, care, and removal of equipment in administrative storage will be in accordance with the applicable requirements of TM 740-90-1 (Administrative Storage of Equipment).

Section II. DESCRIPTION AND DATA

1-7. Description

a. The wheeled warehouse tractor, shown in figure 1-1, is designed for use in warehousing operations, for towing trailers and other wheeled loads. A pintle hook is provided at the rear of the vehicle for the attachment of the load.

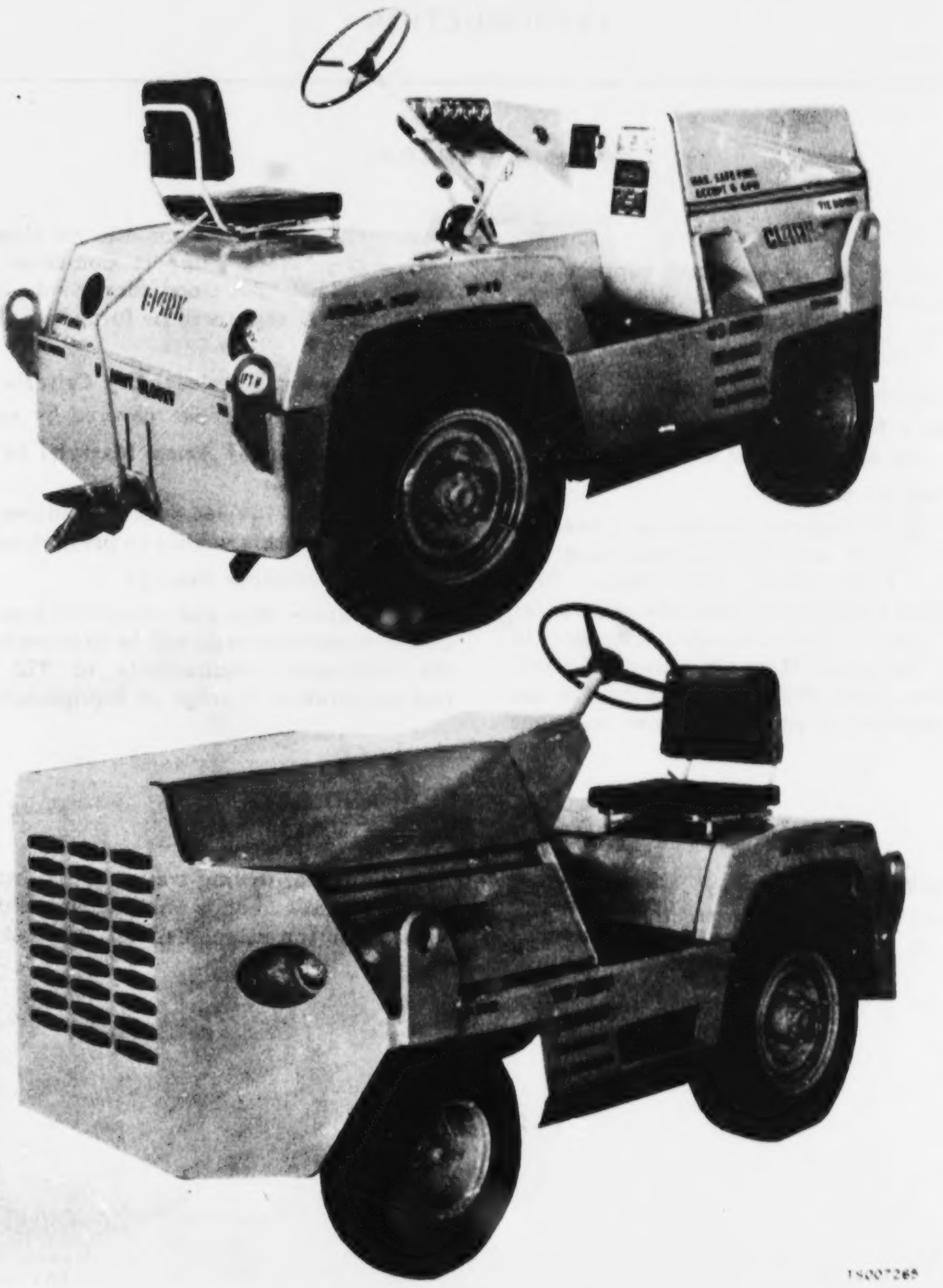


Figure 1-1. Wheeled Warehouse Tractor.

b. The tractor is designed for high maneuverability and ease of operation in warehousing and transfer operations. The vehicle is built in accordance with conventional design for automotive-type vehicles, and is equipped with a gasoline engine, two speed automatic transmission, pneumatic tires, and hydraulic, power boosted brakes. The maintenance paragraphs of this manual contain detailed descriptions of all components.

1-8. Tabulated Data

a. Identification. The tractor has an identification plate mounted to the top right of the firewall in the operator's compartment. This plate specified model, serial, contract, and registration numbers, federal stock number, basic overall dimensions and weight, and warranty information. Mounted below the identification plate is a transportation data plate.

b. Tabulated Data.

(1) *Identification Plate.*

Model	CT"E"-40
Contract No.	DSA700-73-C-9490
Serial No.	------
Capacity	4000 lb drawbar pull
Reg. No.	------
GVW	5800 lb
NSN	3939-00-347-6173
Length	112.5 in.
Height	64.0 in.
Width	55.5 in.
Cube	231.2 ft

(2) *Shipping Data Plate.*

Technical manual number	TM 10-3930-633-12
Center of Gravity:	
Horizontal from center drive wheel axle	---- in.
Vertical above center drive wheel axle	---- in.
Lifting eye capacity (each)	1500 lb

(3) *Engine.*

Manufacturer	Ford Motor Co.
Model	300 LD-1V
Cylinders	6 - in line
Bore (inches)	4.000
Stroke (inches)	3.980
Displacement	300 cu in.
Compression ratio	8.5:1
Governed speed (no-load)	2750 RPM
Governed speed (loaded)	2600 RPM
Net Brake HP @ governed RPM	107
Maximum torque @ 2400 RPM	284 ft/lb
Taxable horse power	38.40
Firing order	1-5-3-6-2-4
Engine idle	500-550 RPM
Engine idle manifold vacuum	17 in./Hg
Ignition timing	6° BTDC
Oil pressure	35-60 PSI
Valve lash (hot and cold)	0
Crankcase capacity:	
With filter	6 quarts
Without filter	5 quarts

(4) *Spark Plugs.*

Gap (inches)	0.032-0.036
Torque	15-20 ft/lb

(5) *Starting Motor.*

Cranking speed (normal engine)	250-290 RPM
Brush spring tension (oz)	40
Brushes (wear limit, inches)	0.25
Brush length (inches)	0.5
Current draw (amps) under normal load	150-180
Volts (minimum stall torque @ volts)	5
Torque (ft/lb) (minimum stall torque @ 5 volts)	15.5
Maximum starting circuit voltage drop (battery plus terminal to starter terminal) @ normal engine temperature	0.5 volts
No-load (amperes)	70
Mounting bolt, 3-hole (5/16") bolt torque	12-15 ft/lb
Mounting bolt, 2-hole (3/8") bolt torque	15-20 ft/lb

(6) *Distributor.*

Cam angle range	35-38°
Brush spring tension (ounces)	17-21
Contact spacing (inches)	0.024-0.026
Shaft end play (inches)	0.003-0.010
Condenser:	
Capacity (microfarads)	.21-.25
Leakage (megohms)	5
Series resistance (ohms)	1

(7) *Battery (negative ground).*

Volts	12
Number of cells	6
Number of plates	11
20 hour rate A.H.	70 ampere hours 300 amps, 0°F. (10 sec.) 2.0 minutes to one volt per cell

(8) *Alternator.*

System voltage	12
System ground	negative
Amperes	32
Maximum ambient temperature	200°F
Rotation	CW
Pulley nut torque (ft/lb)	40-60
Battery terminal nut torque (in./lb)	20-25
Ground terminal nut torque (in./lb)	15-20
Field coil draw @ 80°F	2.2-2.6 Amps @12 volts
Rated hot output	32 Amps
Output test @ 80°F	14 volts, 21 Amps @ 2000 RPM (Approx) and 20 Amps @ 5000 RPM (Approx)
Charging starts cold	1000 RPM (Alternator)
Charging starts hot	1050 RPM (Alternator)

(9) *Transmission.*

Model	Ford FMX
Speeds	2 forward, 1 reverse (low gear blocked out in drive range)
Gear ratio:	
Low	1.47 to 1.0
High	1.0 to 1.0
Reverse	2.0 to 1.0
Fluid capacity	11 quarts

(10) *Wheels and Tires.*

Front wheels:	
Tire size	6:50x10—6 ply
Pressure	100 PSI
Wheel nut torque	60-75 ft/lb

Rear wheels:	
Tire size	6:50x16–6 ply
Pressure	45 PSI
Wheel nut torque	125-140 ft/lb

(11) *Front Axle.*

Toe-in	0°
Camber	1°
Caster	0°
Steering cramp angle:	
Inside wheel	56°
Outside wheel	36½°

(12) *Rear Axle.*

Ratio	17.311:1
Lubricant capacity	10 quarts

(13) *Brakes.*

Type	Power assisted, two-shoe
Master cylinder	Tandem, split system
Power unit	Vacuum suspended, diaphragm
Total braking area	162 sq in.
Pedal free travel	½ in.

(14) *Dimensions and Weights.*

Rear tread	54.5 in.
Turning radius:	
Outside	108 in.
Inside	29 in.
Ground clearance (under counterweight tow hitch or mounting)	11 in.
Ground clearance (under rear axle)	7 in.
Ground clearance (under front axle)	6½ in.
Ground clearance between axles	8 in.
Grade clearance	34%
Drawbar pull	2000 to 5000 lbs, at 12 in. coupler height
Travel speeds:	
Empty: 1st	8.9 MPH
2nd	13.1 MPH
Rev.	6.5 MPH

(15) *Capacities.*

Crankcase oil (incl. filter)	6 quarts
Transmission oil	11 quarts
Rear axle	10 quarts
Cooling system	16 quarts
Fuel tank	17 gallons

1-9. Differences in Models

This manual covers the Army Model MHE-228 Wheeled Warehouse Tractor, (Clark Equipment Model 2330237). No differences exist in the units delivered under this contract.

CHAPTER 2

DIRECT SUPPORT AND GENERAL SUPPORT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS, SPECIAL TOOLS AND EQUIPMENT

2-1. General

No special tools or equipment are required to perform the direct support and general support maintenance procedures outlined in this manual. Although some of the illustrations within the repair chapters depict the use of specially fabricated tools designed by the engine manufacturer, the use of such tools is not mandatory for the successful performance of the required procedure, and all required procedures may be readily accomplished by use of tools normally available at direct and general support level.

2-2. Direct Support, General Support, and Depot Maintenance Repair Parts

Repair parts are listed and illustrated in the Repair Parts and Special Tools List for Direct Support, General Support and Depot Maintenance, TM 10-3930-633-34P.

Section II. TROUBLESHOOTING

2-3. General

a. This section contains troubleshooting information for locating and correcting most of the operating troubles which may develop in the warehouse tractor. See table 2-1. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections which will aid in determining probable causes and corrective actions to take. Perform these tests/inspections and corrective actions in the order listed.

b. This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions, notify your supervisor.

Table 2-1. Troubleshooting

MALFUNCTION
    TEST OR INSPECTION
        CORRECTIVE ACTION

FUEL SYSTEMS

1. FUEL NOT REACHING CARBURETOR.
    Step 1. Check fuel level in tank, also check for dirt or sediment in bottom of tank.
        Drain and/or refill fuel tank.
    Step 2. Check for damaged or leaky fuel lines between fuel tank and carburetor.
        Repair or replace damaged fuel lines (see TM 10-3930-633-12).
    Step 3. Check fuel filter element for obstructions.
        Replace fuel filter (see TM 10-3930-633-12).
    Step 4. Check to see if fuel pump is delivering sufficient fuel (see TM 10-3930-633-12).
        Replace fuel pump (see TM 10-3930-633-12).
2. CARBURETOR NOT DELIVERING PROPER MIXTURE.
    Step 1. Check for improper choke adjustment.
        Adjust to provide full opening with choke control pushed fully in (see TM 10-3930-633-12).
    Step 2. Remove carburetor and check for stuck float or blocked fuel passage.
        Disassemble and repair carburetor (see para. 3-4).
3. HIGH FUEL CONSUMPTION.
    Step 1. Check carburetor adjustment.
        Adjust carburetor to specifications (see TM 10-3930-633-12).

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

FUEL SYSTEM—Continued

3. HIGH FUEL CONSUMPTION—Continued

Step 2. Check governor adjustment.

Adjust governor to specifications (see TM 10-3930-633-12).

Step 3. Check fuel lines and fuel tank for leakage.

Replace or tighten leaky fuel lines (see TM 10-3930-633-12). Repair fuel tank (para. 4-2).

Step 4. Check engine operating temperature; overheated engine will use excessive fuel.

Refer to cooling systems tests (see TM 10-3930-633-12).

Step 5. Check engine timing.

Correct timing to specifications (see TM 10-3930-633-12).

Step 6. Check for weak spark.

Refer to ignition system tests (see TM 10-3930-633-12).

Step 7. Check for restricted air cleaner.

Service air cleaner (see TM 10-3930-633-12).

Step 8. Check for low engine compression.

If compression is low, overhaul engine (Chapter 6).

Step 9. Check for dragging brakes.

Adjust brake lining clearance (see TM 10-3930-633-12).

Step 10. Check tires for low inflation pressure.

Inflate front tires to 100 PSI, rear tires to 45 PSI.

COOLING SYSTEM

1. LOSS OF (COOLANT).

Step 1. Check for leaks at radiator and hose connections.

Replace defective hoses, tighten loose clamps (See TM 10-3930-633-12). Remove and repair radiator (para. 5-3).

Step 2. Check for engine overheating, causing afterboil.

Refer to engine overheating tests and inspections (see TM 10-3930-633-12).

Step 3. Check for leakage at water pump.

Replace leaking water pump (see TM 10-3930-633-12).

Step 4. Check for evidence of water in engine crankcase, indicating cracked cylinder head or blown head gasket.

Replace cylinder head and gasket (see TM 10-3930-633-12).

Step 5. Check for evidence of water in transmission fluid, indicating a leak in the oil cooler.

Replace radiator (see TM 10-3930-633-12).

2. ENGINE OVERHEATS.

Step 1. Check coolant level.

Fill radiator to proper level.

Step 2. Remove and test thermostat.

Replace inoperative thermostat (see TM 10-3930-633-12).

Step 3. Check for broken or loose fan belt.

Tighten or replace fan belt (see TM 10-3930-633-12).

Step 4. Check radiator for obstruction.

Clean away obstruction; steam clean radiator core (see TM 10-3930-633-12).

Step 5. Check for proper coolant flow through radiator.

Pressure flush radiator to clear obstructions. Replace thermostat, if sticking (see TM 10-3930-633-12).

Step 6. Check ignition timing.

Set timing to specifications (see TM 10-3930-633-12).

Step 7. Check water pump for broken impeller.

Repair water pump (see TM 10-3930-633-12).

Step 8. Check for restricted air cleaner.

Replace air cleaner element, clear obstruction from air intake system (see TM 10-3930-633-12).

Step 9. Check for bent or clogged exhaust pipe or muffler, creating excessive back pressure.

Replace damaged parts (see TM 10-3930-633-12).

3. ENGINE RUNNING TOO COOL.

Step 1. Check operation of thermostat in restricting cold water flow through radiator.

Replace stuck thermostat (see TM 10-3930-633-12).

Step 2. Check to determine if overcooling is the result of extended outside operation in low ambient temperatures.

Cover part of radiator core to obstruct air flow.

ELECTRICAL SYSTEM

1. BATTERY WEAK OR FAILS TO MAINTAIN CHARGE.

Step 1. Check battery electrolyte level.

Add distilled water to cover plates, check for cracked case and replace battery if cracks are found.

Step 2. Check for shorted cell in battery.

Replace battery.

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

ELECTRICAL SYSTEM—Continued

1. BATTERY WEAK OR FAILS TO MAINTAIN CHARGE—Continued

Step 3. Check alternator belt tension and output.

Tighten alternator belt tension. Replace or repair alternator if output is low and regulator adjustment does not correct.

Step 4. Check voltage regulator adjustment (see TM 10-3930-633-12).

Adjust regulator to specifications. Replace regulator if adjustment cannot be maintained.

Step 5. Check for excessive use of starter or dragging starter resulting in excessive battery drain.

Tune engine for easy starting or replace a dragging starter.

Step 6. Check for short to ground in electrical wiring.

Correct short condition.

2. STARTER CRANKS ENGINE SLOWLY.

Step 1. Check state of battery charge.

Refer to Item 1, "BATTERY WEAK."

Step 2. Check for loose or corroded battery cable terminals.

Clean and tighten battery cable terminals (see TM 10-3930-633-12).

Step 3. Check for excessive amperage draw within starting motor.

Replace or repair starter (para. 2-6).

3. STARTER WILL NOT CRANK ENGINE.

Step 1. Check for loose, corroded, or broken cables to starting motor and solenoid switch.

Replace defective cables. Clean and tighten all cable terminals (see TM 10-3930-633-12).

Step 2. Check starter solenoid action.

Replace defective solenoid switch.

Step 3. Check make-and-break action of neutral start switch using ohmmeter.

Replace defective switch.

Step 4. Test starter for short or open circuit (see TM 10-3930-633-12).

Replace or repair defective starter.

Step 5. Check starter mounting; if loose, starter pinion may not engage flywheel.

Tighten starter mounting bolts.

IGNITION SYSTEM

1. ENGINE WILL NOT START.

Step 1. Check for spark at plugs; if no spark at plugs, perform all ignition system tests outlined in TM 10-3930-633-12.

Step 2. Examine rotor and distributor cap for cracks, burned areas, corrosion, and carbon tracking.

Replace defective rotor and distributor cap, repair distributor (para. 2-8).

Step 3. Refer to "ENGINE" section of this table for further troubleshooting information.

2. ENGINE RUNS ROUGH OR MISSES.

Step 1. Check all ignition system components as outlined in TM 10-3930-633-12.

Step 2. Refer to "ENGINE" section of this table for further troubleshooting information.

3. ENGINE PINGS OR KNOCKS UNDER LOAD.

Step 1. Check ignition timing.

Adjust to proper timing (see TM 10-3930-633-12).

Step 2. Check distributor advance mechanism for proper operation (see TM 10-3930-633-12).

Repair distributor (para. 2-8).

Step 3. Refer to "ENGINE" section of this table for further troubleshooting information.

ENGINE

1. ENGINE WILL NOT START.

Step 1. Perform checks under "FUEL SYSTEM," (See TM 10-3930-633-12).

Step 2. Perform checks under "IGNITION SYSTEM," (See TM 10-3930-633-12).

Step 3. Check for low compression (para. 6-8).

Overhaul engine (Chapter 6, Section III).

2. ENGINE BACKFIRES, MISSES OR OPERATES ERRATICALLY.

Step 1. Check malfunctions under "IGNITION SYSTEM."

Step 2. Check for manifold vaccum leak (para. 6-7).

Repair cause of leak, according to test results.

Step 3. Check compression (para. 6-8).

Repair cause of poor compression, according to test results.

Step 4. Check for broken valve spring.

Replace valve spring (para. 6-19).

Step 5. Check for excessive carbon build-up in cylinder head.

Overhaul cylinder head and valves (see Chapter 6, Section IV).

Step 6. Check valve timing.

Align camshaft gear timing marks (see Chapter 6, Section VIII).

ENGINE—Continued

3. ENGINE LACKS POWER.

Step 1. Check malfunctions under "FUEL SYSTEM."

Step 2. Check malfunctions under "IGNITION SYSTEM."

Step 3. Perform compression check. para. 6-8.

Repair cause of poor compression, according to test results.

Step 4. Perform manifold vacuum test (para. 6-7).

Repair cause of vacuum leak, according to test results.

Step 5. Check for broken valve spring (para. 6-19).

Replace broken valve spring (para. 6-21).

4. HIGH OIL CONSUMPTION.

Step 1. Check for oil leaks at pan, gasket surfaces or crankshaft main seals.

Replace pan gaskets. Replace main seal (paragraphs 6-35 and 6-36).

Step 2. Check for improper grade and type of oil.

Drain and refill with proper grade and type of oil (see LO 10-3930-633-12).

Step 3. Check for engine overheating; causing thinning of oil.

Refer to "COOLING SYSTEM" for causes of overheating.

Step 4. Perform compression check to determine if rings and valve guides are excessively worn.

Overhaul engine (Chapter 6).

Step 5. Check crankshaft main bearing and connecting rod bearing clearance (Chapter 6, Section VII).

Fit new bearings (para. 6-33).

5. LOW COMPRESSION.

Step 1. Inspect valves and valve seats for wear.

Overhaul cylinder head (Chapter 6, Section IV).

Step 2. Check pistons, rings and cylinder bores for excessive clearance, wear and scoring.

Overhaul engine (Chapter 6).

Step 3. Check cylinder head and block for cracks, warped gasket surfaces, or broken gaskets.

Overhaul engine (Chapter 6).

6. LOW OR NO OIL PRESSURE.

Step 1. Check oil level.

Fill crankcase with proper quantity and type of oil (see LO 10-3930-633-12).

Step 2. Check for oil leakage at cylinder head, crankshaft main seals, or timing chain cover.

Repair or replace as required (see Chapter 6).

Step 3. Check oil pump for internal wear (para. 6-44).

Repair oil pump para. 6-45).

7. BEARING FAILURE.

Step 1. Check oil pump for proper operation (para. 6-44).

Repair oil pump (para. 6-45).

Step 2. Check crankshaft journals for out-of-round or roughness (para. 6-30).

Replace crankshaft (para. 6-29). Refer damaged crankshaft to depot maintenance for reconditioning.

Step 3. Check connecting rod trueness (para. 6-31).

Replace or straighten bent rod (para. 6-28).

8. VALVES STICKING OR BURNED.

Step 1. Check valve stem clearance (para. 6-17).

Overhaul cylinder head (Chapter 6, Section IV).

Step 2. Check for weak, bent or broken valve spring.

Replace defective valve spring (para. 6-21).

Step 3. Test for seized or defective valve lifter (para. 6-20).

Replace defective lifter (para. 6-21).

Step 4. Check valve timing.

Retime camshaft (Chapter 6, Section VIII).

Step 5. Check valve stem straightness and finish (para. 6-17).

Replace bent or worn valves.

PROPELLER SHAFT

1. NOISY OPERATION.

Step 1. Check for lack of lubrication.

Lubricate in accordance with LO 10-3930-633-12.

Step 2. Check for worn or damaged bearings.

Repair propeller shaft (para. 8-2).

Step 3. Check for loose or improper mounting.

Tighten and correct as required.

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

PROPELLER SHAFT—Continued

2. EXCESSIVE VIBRATION.
   - Step 1. Check for mud, road tar or other foreign material on shaft which disturbs shaft balance.
     - Clean and repair as required.
   - Step 2. Check for bent shaft.
     - Replace (para. 8-2).

TRANSMISSION

1. TRANSMISSION WILL NOT ENGAGE.
   - Step 1. Check fluid level.
     - Refill with proper fluid (see LO 10-3930-633-12).
   - Step 2. Check to see if control cable has become disconnected.
     - Reconnect control cable at selector or transmission.
   - Step 3. Perform transmission tests outlined in Chapter 7.
     - Repair transmission according to test results.
2. TRANSMISSION OPERATES ERRATICALLY.
   - Step 1. Check for low fluid level.
     - Refill with proper fluid (see LO 10-3930-633-12).
   - Step 2. Check for fluid foaming due to overfilling.
     - Drain level back to FULL mark on dipstick.
   - Step 3. Check control cable and linkage adjustment.
     - Adjust control cable or linkage (see Chapter 7).
   - Step 4. Perform transmission tests outlined in Chapter 7.
     - Repair transmission according to test results.
3. TRANSMISSION FLUID OVERHEATS.
   - Step 1. Check for dragging parking brake or service brake.
     - Adjust brakes to eliminate drag (see TM 10-3930-633-12).
   - Step 2. Check for overheated cooling system.
     - Perform tests and corrective actions listed under "COOLING SYSTEM."
   - Step 3. Check for constant, low speed, overloaded operation.
     - Reduce vehicle loading.

BRAKES

1. POOR BRAKE ACTION, HIGH PEDAL PRESSURE REQUIRED.
   - Step 1. Check fluid level in master cylinder.
     - Fill master cylinder reservoir to within one inch of filler neck.
   - Step 2. Check for leaks in vacuum line to booster.
     - Tighten or replace vacuum line.
   - Step 3. Check for grease on brake linings.
     - Replace defective grease seal; reline brakes (para. 9-6).
   - Step 4. Check for excessively worn or glazed lining.
     - Reline brakes (para. 9-6).
   - Step 5. Check for leakage in hydraulic lines to wheel cylinders or master cylinder.
     - Correct leaks, replace lines and fittings as required, bleed brakes (see TM 10-3930-633-12).
   - Step 6. Check for master cylinder leakage.
     - Repair master cylinder (see TM 10-3930-633-12).
   - Step 7. Check for leaking wheel cylinders.
     - Repair wheel cylinders (para. 9-6).
   - Step 8. Check engine vacuum (para. 6-7).
     - Repair cause of vacuum loss according to test results.
   - Step 9. Check for internal leakage in vacuum booster (para. 9-9).
     - Repair vacuum unit.
2. UNEVEN, NOISY, GRABBING BRAKES.
   - Step 1. Check for excessive dirt or dust in brake drum or lining.
     - Blow out with compressed air.
   - Step 2. Check for grease seal or wheel cylinder leakage.
     - Replace grease seal (see TM 10-3930-633-12). Repair wheel cylinder(s) (para. 9-6).
   - Step 3. Check for out-of-round drum.
     - Replace out-of-round drum (para. 9-7).
   - Step 4. Check for excessive scoring or brake drum wear.
     - Turn or replace drums (para. 9-7).
   - Step 5. Check for warped or misaligned shoes.
     - Rebuild brakes using new shoes (para. 9-6).

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

BRAKES—Continued

2. UNEVEN, NOISY, GRABBING BRAKES—Continued

Step 6. Check for frozen (corroded) master cylinder or wheel cylinder pistons.

Repair defective cylinders.

Step 7. Check for glazed linings.

Remove glaze from linings. Use sandpaper P-P-101.

3. BRAKES DO NOT RELEASE.

Step 1. Check for improperly adjusted brake pedal (see TM 10-3930-633-12).

Adjust pedal free travel.

Step 2. Check for restricted by-pass port in master cylinder.

Rebuild master cylinder (see TM 10-3930-633-12).

Step 3. Check for swollen master cylinder cups.

Rebuild master cylinder (see TM 10-3930-633-12).

Step 4. Check for sticking wheel cylinders.

Rebuild wheel cylinders (para. 9-6).

Step 5. Check for broken return springs, warped or misaligned shoes or backing plate.

Overhaul brakes (para. 9-6).

REAR AXLE

1. CONTINUOUS NOISE FROM AXLE.

Step 1. Check for low lubricant level.

Refill to proper level (see LO 10-3930-633-12 and TM 10-3930-633-12).

Step 2. Check for uneven tire sizes or pressure.

Install correct tire size and inflate to proper pressure (45 PSI).

Step 3. Check rear wheel bearings for wear.

Adjust or replace wheel bearings as required (see TM 10-3930-633-12).

Step 4. Check for loose mounting bolts around differential mounting or reduction gearcase.

Tighten loose mounting bolts.

Step 5. Disassemble differential and check for missing gear teeth, worn bearings, broken parts, etc.

Repair or replace as required (para. 10-4).

Step 6. Disassemble reduction gear case and check for missing gear teeth, worn bearings, broken parts, etc.

Repair or replace as required (para. 10-3).

2. NOISE FROM AXLE ON TURNS ONLY.

Step 1. Check adjustment of rear wheel bearings.

Adjust rear wheel bearings as required (see TM 10-3930-633-12).

Step 2. Remove and disassemble differential; check for damaged side gears, pinions, etc.

Repair or replace as required (para. 10-4).

STEERING/FRONT AXLE/SPRINGS

1. STEERING REQUIRES EXCESSIVE EFFORT.

Step 1. Check for low air pressure in tires.

Inflate tires to proper air pressure (45 PSI rear, 100 PSI front).

Step 2. Check for stiffness in tie rod ends, steering knuckles and steering gear due to lack of lubrication.

Lubricate all items in accordance with LO 10-3930-633-12.

Step 3. Check for bent or misaligned tie rod or drag link.

Replace damaged drag link. Repair tie rod (para. 11-2).

2. TRACTOR WANDERS OR WEAVES.

Step 1. Check front wheel toe-in.

Adjust to specifications (para. 11-2).

Step 2. Check for loose drag link connections.

Tighten drag link ball stud ends to eliminate play in steering linkage.

Step 3. Check for excessive play in front wheel bearings.

Adjust front wheel bearings to specifications (see TM 10-3930-633-12).

Step 4. Check for excessive play in steering gear due to wear.

Overhaul steering gear (para. 11-3).

Step 5. Check for loose steering gear mounting bolts.

Tighten all steering gear mounting bolts.

3. NOTICEABLE PULL TO ONE SIDE.

Step 1. Check front tires for mismatch, or low air pressure.

Install tires of same size on both wheels. Inflate to 100 PSI (front wheels).

Step 2. Check wheel bearings for tight adjustment.

Adjust wheel bearings to eliminate binding (see TM 10-3930-633-12).

Step 3. Check tie rod adjustment/wheel alignment.

Align front wheels (para. 11-2).

MALFUNCTION

TEST OR INSPECTION

CORRECTIVE ACTION

STEERING/FRONT AXLE/SPRINGS—Continued

3. NOTICEABLE PULL TO ONE SIDE—Continued

Step 4. Check for dragging brake shoe on one side.

Adjust brake to eliminate shoe drag (see TM 10-3930-633-12).

4. NOISE FROM FRONT AXLE.

Step 1. Check wheel mounting nuts for security.

Tighten as required.

Step 2. Check wheel bearing adjustment.

Adjust wheel bearings (see TM 10-3930-633-12).

5. SHIMMY OR WOBBLE.

Step 1. Check for loose spring shackle or U-bolt.

Tighten and replace parts as required.

Step 2. Check for broken spring leaf.

Replace spring (para. 12-3).

Step 3. Check for bent axle or steering knuckle arm.

Straighten or replace parts as required.

Section III. GENERAL MAINTENANCE

2-4. General

Instructions within this section provide for removal and repair of all major components and assemblies of the vehicle. It is assumed that organizations undertaking such depth of repair shall have proper facilities and equipment for proper performance of the work. The following paragraphs 2-5 through 2-10 provide general instructions to be used as a guide in performing disassembly, cleaning, inspection, repair, and reassembly.

CAUTION

Prior to performing any repair by welding, refer to paragraph 2-11 for specific instructions regarding welding of highly stressed parts.

2-5. General Removal Instructions

a. Before attempting removal of any electrical component, make certain that the system is not energized. Disconnect battery ground strap.

b. Insure that adequate clearance is available for removal of the component. Disassemble the truck to the extent necessary to provide adequate working clearance.

c. Use a chain hoist, jack or other aid when lifting the heavier components. The lifting device should be positioned and attached to the component to remove all strain from the mounting hardware before the last of the hardware is removed.

d. To facilitate reassembly and installation, apply identifying tags to mating ends of electric or hydraulic lines as they are disconnected. Identify parts of similar configuration to insure correct reassembly.

2-6. General Disassembly

a. Preformed packings, gaskets, seals, and similar material should be discarded when removed. Do not use metal tools to remove sealing material. To prevent damage to mating surfaces, use wood or plastic as probes.

b. Cotter pins, lockwashers, lockwire, self-locking nuts, and any similar locking devices shall be discarded when removed.

c. To facilitate reassembly and installation, apply identifying tags to mating points of electric and hydraulic lines, etc., when they are disconnected. Identify parts of similar configuration to ensure correct reassembly.

d. To prevent moisture and foreign matter from entering open housings, lines, and other openings, apply protective covers as soon as practical after disassembly. Wrap all parts in clean paper or dip parts in preservative oil, Military Specification MIL-C-8188, or equivalent.

e. Remove only those parts requiring repair or replacement. Do not disassemble a component any further than necessary to accomplish needed repairs.

2-7. General Cleaning

a. When cleaning ball or roller bearings, place them in a basket and suspend them in a container of dry cleaning solvent overnight. If necessary, use a brush to remove caked grease, chips, etc. Avoid rotating the bearing before solid particles are removed to prevent damaging races and balls. When bearings have been cleaned, spin them immediately in light lubricating oil to remove solvent.

b. Do not clean preformed packings or other rubber parts in dry cleaning solvent. These parts should be wiped clean with a clean, dry, lint-free cloth.

c. Prior to disassembly of the vehicle, the exterior parts of the equipment should be thoroughly cleaned to remove accumulated mud, tar, and grease. This procedure will facilitate inspection and disassembly. For cleaning exterior parts, use a vapor pressure spray rinse cleaner.

d. For cleaning the exterior of the engine, frame and hoods, use Gun, Engine, Kerosene Spray, Stock No. 7900-402730, or equivalent. Use Compound, Aircraft Cleaning, Military Specification MIL-C-25769, in a mixture consisting of one part compound with four to nine parts dry cleaning solvent, Federal Specification P-D-680. Allow application to remain on item surface for approximately 10 minutes before rinsing. Rinse with hot or cold water under pressure. If available, use hot water under 80 to 120 pounds pressure. An ordinary garden hose with nozzle may be used if other equipment is not available. Rinse thoroughly.

CAUTION

Do not clean tires, lubricant seals, rubber hoses, or electrical components with preceding cleaning agent.

e. Electrical parts, such as coils, junction blocks, switches, and wiring, incorporating insulating materials should not be soaked or sprayed with cleaning solutions. Clean these parts with a clean, lint-free cloth moistened with dry cleaning solvent, Federal Specification P-D-680.

f. Oil and fuel tanks and similar reservoirs should be flushed, using a spray gun and dry cleaning solvent.

CAUTION

Do not use soap or alkalies for cleaning tank interiors.

g. The cooling system radiator core should be cleaned with steam or hot water. If sediment within the core cannot be completely removed by this method, the core may be boiled in a solution of sodium carbonate and water. Use a solution of one pound of sodium carbonate, Federal Specification O-S-571, to each gallon of water. Flush with clean, hot water, or steam.

h. The electrical system battery exterior surfaces should be cleaned with a weak solution of baking soda and water. Apply the solution with a bristly brush to remove any corrosive buildup on the battery cable clamps and terminals and battery tray.

i. When cleaning hydraulic system components, use petroleum-free solvents. Clean and dry parts thoroughly to make sure that no residue remains. If a coating of preservative is required prior to reassembly, apply a light film of preservative oil, Military Specification MIL-O-6083. If petroleum-free solvents are not available for cleaning, use hydraulic fluid compatible with that used in the vehicle system.

CAUTION

Do not use gasoline or other petroleum base products to clean or preserve hydraulic system components.

j. Wash painted surfaces of vehicle with a solution consisting of ¼ lb of soap chips, Federal Specification P-S-579, to 1 gallon of water.

2-8. General Inspection

a. Examine bearings for rusted or pitted balls, races, or separator. Examine balls and races for brinnelling, abrasion, and serious discoloration. The following are causes for bearing rejection.

(1) Cuts or grooves parallel to ball or roller rotation.

(2) Fatigue pits (as opposed to minor machine marks or scratches).

(3) Cracks detected during magnetic particle inspection.

NOTE

Excluding defects which may cause bearing binding or misalignment, nicks or gouges outside race load areas are not cause for rejection.

b. Inspection consists of checking for defects such as physical distortion, wear, cracks, and pitting, and checking dimensions of parts for compliance with maximum wear limits data. Parts subjected to heavy load or pressure shall be inspected more thoroughly by performing surface temper, magnetic particle, or fluorescent penetrant procedures where necessary. Clean all parts before inspection.

c. When removing drain plugs from transmission, engine, or hydraulic system components, inspect the sediment adhering to the plug. Accumulations of grit and/or fine metal particles may indicate actual or potential component failure. A few fine particles are normal. This inspection is effective in determining defective parts prior to internal inspection of the component, and to predict degradation of the equipment.

d. Gears should be inspected upon removal for the following conditions:

(1) Normal wear in excess of practical limits.

(2) Pitting of teeth due to extreme pressure loading.

(3) Abrasive wear due to foreign materials in lubricant.

(4) Scoring, seizing, and galling of teeth due to excessive loads and clearance.

(5) Burning and loss of temper due to extreme high temperature operation. Caused by excessive friction and lack of lubrication.

(6) Rolling or plastic yielding due to extreme loads over a long period.

(7) Cracks and fractures due to shock-loading.

NOTE

If visual inspection proves the service of gears doubtful, perform a surface temper or magnetic particle inspection, or both.

e. Inspect shaft splines for wear, pitting, rolling or peening, and for fatigue cracks. In many instances, the same inspection procedure will apply as for gears. However, the condition, if ever present, will in most cases be much less pronounced. When doubtful of the actual serviceable condition of splines, perform a magnetic particle inspection.

f. Check all hose surfaces for broken or frayed fabric. Check for breaks caused by sharp kinks or rubbing against other parts of the truck. Inspect copper tubing lines for kinks. Inspect the fitting threads for damage. Replace any part found defective. Following reassembly and during initial truck operation period, check for leaks.

g. Visually inspect all castings and weldments for cracks. Parts upon which great stress is placed may be inspected further, using the magnetic particle inspection method. Critical non-ferrous parts may be fluorescent penetrant inspected.

h. Inspect all harnesses for chaffed or burned insulation. Inspect all terminal connectors for loose connections and broken parts.

2-9. General Repair

a. Remove burrs from gear teeth with a fine-cut file or hand grinder.

b. Alternator sliprings and starter commutators may be polished in a lathe, using a strip of 00 sandpaper. After polishing, blow all dust and residue from commutator with compressed air.

c. Chassis and exterior painted parts may be resurfaced where paint is damaged, or where parts have been repaired, by using an abrasive disc driven through a flexible shaft.

CAUTION

Suitable precautions should be taken to guard other parts of the vehicle from abrasive dust. The operation should not be performed near exposed working parts and all openings which would allow the dust to reach working parts should be masked.

d. Remove residue and oil stain from bearing races with crocus cloth.

e. Prior to resurfacing, scrape off loose and blistered paint from damaged areas. Clean area to be painted by sanding or buffing. Remove residue cleaning material with paint thinner, Federal Specification TT-T-306, and dry thoroughly.

f. During repair operations, bare steel surfaces shall be protected from oxidation when not actually undergoing repair work, i.e., while awaiting any repair step, re-inspection or reassembly. Such protection shall be accomplished by dipping the parts in, or spraying them with corrosion preventive compound, Military Specification MIL-C-6259. The same protective coating shall be applied to other metals, if necessary to prevent oxidation under climatic or atmospheric conditions prevailing. Aluminum parts may require protection in atmospheres having a high salt content. Steel parts must be protected in all instances.

NOTE

The above instruction is applicable to polished and machined steel parts not protected by cadmium, tin, copper, or other plating or surface treatment. Bare metal surfaces must be free of moisture when applied. Acid present in perspiration and skin oils may attack steel surfaces if fingerprints are not removed. Dip parts in fingerprint remover compound, Military Specification MIL-C-15074, after handling, to prevent such action.

g. Welding and brazing processes may be employed for the repair of cracks in external steel parts, such as brackets, panels, and light framework. Refer to paragraph 2-11 for specific welding instructions.

h. Replace all broken, worn, or burned electrical wiring. Wires on which several strands are broken must be replaced. Broken strands will increase the resistance of the wire and impair efficiency of the electrical components, especially the ignition system.

i. Replace all broken, frayed, crimped, or soft flexible lines and hoses. Replace fittings which are stripped or damaged. Replace entire flexible hose if fittings are damaged. Make sure the hose clamps do not crimp hoses.

j. Replace any bolt, screw, nut, or fitting on which threads are damaged. Inspect tapped holes for thread damage. If cross-threading or spalling is evident, retap the hole for the next oversize screw or stud. When retapping will result in weakening the part, or when the cost of the part makes retapping impractical, replace the damaged part. At times, merely chasing the threads with the proper size tap or die will be adequate.

2-10. General Reassembly

a. Remove protective grease coatings from new parts prior to installation.

b. To replace a preformed packing, first dovetail groove, then stretch packing and place into position. Rotate component on flat surface, applying a downward pressure to uniformly press the packing into position.

c. To provide added sealing for gaskets, coat both sides with non-hardening oil resistant sealing compound (MIL-S-45180B). Be sure that all traces of previous gasket and sealant are removed before installing new gasket.

d. Install oil seals with seal lip facing in, applying an even force to the outer edge of seal. Coat oil seals evenly with oil or grease before installing. If oil seals are to be installed over keyed or splined shafts, use a guide to prevent sharp edges of the keyway of splines from cutting the leather or neoprene seal. Guides can be constructed of very thin gage sheet metal and shaped to the required diameter. However, make certain the guide edges are not sharp and are bent slightly inward so they do not cut the seal.

e. During reassembly of shafts and bearings in housing, first mount bearing on shaft, then install the assembly by applying force to the shaft. When mounting bearings on shafts, always apply force to the inner races.

f. Lubricate all preformed packings with a thin coating of light mineral oil before installation.

g. Lubricate bearings prior to reassembly with the type of lubricant normally used in the related housing or container. This will provide lubrication during the first run-in until lubricant from the system can reach the bearings.

2-11. Repair Welding

2-12. General

The manufacturer has historically opposed field repair of critical components of any of their products. It is recommended, rather, that the failed or damaged component be replaced at the lowest serviceable level. The manufacturer does, however, recognize that situations may arise in which replacement of the part(s) is not feasible for reasons of time limitations, spare parts shortages, etc.

a. In those cases of emergency where welding repair is apparently the only practical means of restoring the serviceability of the vehicle, the instructions given below must be rigidly followed.

b. Personnel should be cautioned against adding brackets and attachments by welding for personal interests. The nature of this practice invites disregard for good welding design, as well as creating unnecessary visibility problems for the operator.

2-13. Welding Practices

The surfaces of parts to be welded shall be free from paint, grease, and scale which can be removed by chipping and wire brushing, and other foreign matter. When multiple layers of weld metal are required, each layer shall be thoroughly cleaned before depositing another layer. All welded parts and assemblies shall be free from cracks and other imperfections that may reduce the effectiveness of the part or assembly. All weldments shall be free from slag, flux, weld spatter, and other impurities detrimental to the strength and soundness of the weld. Work shall be positioned for flat welding whenever practicable. Butt type joints having members of equal thickness shall be aligned within 10 percent of the thickness of the members involved. Weldments shall be free from overlays. Undercut in weldments of type 2 and type 3 steels shall not be more than 0.01 inch deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall be not more than 1/32-inch deep when its direction is parallel to the primary stress in the part that is undercut.

2-14. Pre-inspection

a. The area of the machine to be repaired must be thoroughly cleaned. Steam-cleaning of the entire machine is recommended.

b. It must be remembered that whenever a failure occurs in any component, the same shock forces causing the failure have been present elsewhere in that component, and have been transmitted throughout the structure wherever there is resistance to that force. Because of this factor, a thorough inspection of all members and weld joints so affected must be made, such as:

(1) Reactive frame members
(2) Spring shackles
(3) Engine mounts
(4) Transmission mounts

c. The use of magnetic particle and/or dye penetrant techniques of nondestructive testing for this inspection are highly recommended.

2-15. Safety

a. Protect-o-seal (anti-flashback) fuel tank cap must be in place before grinding, burning, or welding. Preferred procedure is to empty the fuel tank and purge with CO_2.

CAUTION

Before attaching welding ground cable to the machine, be sure that the alternator harness and/ or battery cables are disconnected. This is to prevent burning out the diodes in the alternator because of reverse polarity.

b. Always wear helmet, asbestos gloves, suitable shoes, apron, or other suitably protective clothing when welding.

c. Clothing should be heavy, free from oil or grease. Pockets and cuffs should be protected against sparks and slag.

d. Portable grinders should have proper wheel guards. Operator should be equipped with goggles or safety shield.

e. Always use proper torch, tip, electrode, and holder for the job.

f. Maintain good welding cables, preferably protected by loom.

g. Ground cables to work, never to house systems, hoists, chain falls, etc. Attach welding ground cable to one of the two members being joined. Do not run current through bearings or wear surfaces.

h. Welding area should be clean and dry.

i. Oxygen should never be used as compressed air, in cleaning or drying operations.

j. Do not use rope to suspend work when flame-cutting, grinding, or welding.

2-16. Fire Protection

a. Remove work from hazardous area before cutting or welding. If this is not possible, remove flammable material from work area, or cover with flame arresting material.

b. Correct those conditions where sparks or slag can travel into combustible materials.

c. Keep oil or grease separated from oxygen. This combination is explosive if ignited.

d. Do not allow clothing to collect pure oxygen. In this concentrated or oxygen-enriched condition, materials burn violently.

e. Keep fully charged fire extinguishers nearby. Employ standby assistant with extinguisher during unavoidable hazardous conditions.

2-17. Ventilation

a. Fans on welders and work help to assure good ventilation. Adequate exhaust fans are essential. However, a breeze directed on the arc can destroy the gas shield around the arc.

b. Never use oxygen for ventilation, or as air jet.

c. Avoid all welding or cutting in paint booths, around dip tanks, degreasing, or other naturally hazardous areas.

d. Excessive or continued breathing of smoke, toxic fumes, or dust is injurious. Use respirator in addition to ventilation under severe conditions.

e. Keep all air in work area moving toward exhaust system.

2-18. Filler Metals

a. All stick electrodes for subject contract joints must be low hydrogen coated (herein called L.H.). L.H. electrode E-7018 (AWS Class.) is recommended, except when specially noted.

b. E-7019, E-8018, E-9018, E-10018, E-11018 have AC-DC polarity, reversing current, with a coating of low hydrogen iron powder.

c. L.H. electrodes are supplied from the vendor in hermetically sealed containers, and must have storage care normal to their type. If containers have been opened for electrodes to become exposed to normal (and above) atmospheric humidity, the electrodes should be oven baked at 700 °F. for 1 hour minimum.

d. L.H. electrodes which have been in water should be scrapped.

e. Remove only enough electrodes from the container to perform the immediate job. Open containers should be stored in heated storage containers held at 200° to 300 °F.

f. The manufacturer employs little or no TIG production welding at the factory.

g. The manufacturer employs MIG welding extensively in production welding. Due to its nature however, the welding instruction herein (repair, as opposed to production welding) will deal only with stick electrodes. The precautionary and preparation instruction herein applies also to MIG or TIG welding.

2-19. Preparation

a. In natural ambient temperatures of 60 °F or less, the machine (or component) should be "room soaked" overnight in 70 °F (+) to equate a preheat. If this is impossible, the weld zone (area 6" to 10" each side) should be preheated to a minimum of 100 °F. before welding. This minimum temperature should be maintained on the heat zone of each joint until that joint is completed.

b. Thermal sticks may be used to check these weld heat-affected zones. Timpil sticks are is evident, retap the hole for the next oversize screw or stud. When retapping will result in weakening the part, or when the cost of the part makes retapping impractical, replace the damaged part. At times, merely chasing the threads with the proper size tap or die will be adequate.

2-10. General Reassembly

a. Remove protective grease coatings from new parts prior to installation.

b. To replace a preformed packing, first dovetail groove, then stretch packing and place into position. Rotate component on flat surface, applying a downward pressure to uniformly press the packing into position.

c. To provide added sealing for gaskets, coat both sides with non-hardening oil resistant sealing compound (MIL-S-45180B). Be sure that all traces of previous gasket and sealant are removed before installing new gasket.

d. Install oil seals with seal lip facing in, applying an even force to the outer edge of seal. Coat oil seals evenly with oil or grease before installing. If oil seals are to be installed over keyed or splined shafts, use a guide to prevent sharp edges of the keyway of splines from cutting the leather or neoprene seal. Guides can be constructed of very thin gage sheet metal and shaped to the required diameter. However, make certain the guide edges are not sharp and are bent slightly inward so they do not cut the seal.

e. During reassembly of shafts and bearings in housing, first mount bearing on shaft, then install the assembly by applying force to the shaft. When mounting bearings on shafts, always apply force to the inner races.

f. Lubricate all preformed packings with a thin coating of light mineral oil before installation.

g. Lubricate bearings prior to reassembly with the type of lubricant normally used in the related housing or container. This will provide lubrication during the first run-in until lubricant from the system can reach the bearings.

2-11. Repair Welding

2-12. General

The manufacturer has historically opposed field repair of critical components of any of their products. It is recommended, rather, that the failed or damaged component be replaced at the lowest serviceable level. The manufacturer does, however, recognize that situations may arise in which replacement of the part(s) is not feasible for reasons of time limitations, spare parts shortages, etc.

a. In those cases of emergency where welding repair is apparently the only practical means of restoring the serviceability of the vehicle, the instructions given below must be rigidly followed.

b. Personnel should be cautioned against adding brackets and attachments by welding for personal interests. The nature of this practice invites disregard for good welding design, as well as creating unnecessary visibility problems for the operator.

2-13. Welding Practices

The surfaces of parts to be welded shall be free from paint, grease, and scale which can be removed by chipping and wire brushing, and other foreign matter. When multiple layers of weld metal are required, each layer shall be thoroughly cleaned before depositing another layer. All welded parts and assemblies shall be free from cracks and other imperfections that may reduce the effectiveness of the part or assembly. All weldments shall be free from slag, flux, weld spatter, and other impurities detrimental to the strength and soundness of the weld. Work shall be positioned for flat welding whenever practicable. Butt type joints having members of equal thickness shall be aligned within 10 percent of the thickness of the members involved. Weldments shall be free from overlays. Undercut in weldments of type 2 and type 3 steels shall not be more than 0.01 inch deep when its direction is transverse to the primary stress in the part that is undercut. Undercut shall be not more than 1/32-inch deep when its direction is parallel to the primary stress in the part that is undercut.

2-14. Pre-inspection

a. The area of the machine to be repaired must be thoroughly cleaned. Steam-cleaning of the entire machine is recommended.

b. It must be remembered that whenever a failure occurs in any component, the same shock forces causing the failure have been present elsewhere in that component, and have been transmitted throughout the structure wherever there is resistance to that force. Because of this factor, a thorough inspection of all members and weld joints so affected must be made, such as:

(1) Reactive frame members
(2) Spring shackles
(3) Engine mounts
(4) Transmission mounts

c. The use of magnetic particle and/or dye penetrant techniques of nondestructive testing for this inspection are highly recommended.

2-15. Safety

a. Protect-o-seal (anti-flashback) fuel tank cap must be in place before grinding, burning, or welding. Preferred procedure is to empty the fuel tank and purge with CO_2.

CAUTION

Before attaching welding ground cable to the machine, be sure that the alternator harness and/ or battery cables are disconnected. This is to prevent burning out the diodes in the alternator because of reverse polarity.

b. Always wear helmet, asbestos gloves, suitable shoes, apron, or other suitably protective clothing when welding.

c. Clothing should be heavy, free from oil or grease. Pockets and cuffs should be protected against sparks and slag.

d. Portable grinders should have proper wheel guards. Operator should be equipped with goggles or safety shield.

e. Always use proper torch, tip, electrode, and holder for the job.

f. Maintain good welding cables, preferably protected by loom.

g. Ground cables to work, never to house systems, hoists, chain falls, etc. Attach welding ground cable to one of the two members being joined. Do not run current through bearings or wear surfaces.

h. Welding area should be clean and dry.

i. Oxygen should never be used as compressed air, in cleaning or drying operations.

j. Do not use rope to suspend work when flame-cutting, grinding, or welding.

2-16. Fire Protection

a. Remove work from hazardous area before cutting or welding. If this is not possible, remove flammable material from work area, or cover with flame arresting material.

b. Correct those conditions where sparks or slag can travel into combustible materials.

c. Keep oil or grease separated from oxygen. This combination is explosive if ignited.

d. Do not allow clothing to collect pure oxygen. In this concentrated or oxygen-enriched condition, materials burn violently.

e. Keep fully charged fire extinguishers nearby. Employ standby assistant with extinguisher during unavoidable hazardous conditions.

2-17. Ventilation

a. Fans on welders and work help to assure good ventilation. Adequate exhaust fans are essential. However, a breeze directed on the arc can destroy the gas shield around the arc.

b. Never use oxygen for ventilation, or as air jet.

c. Avoid all welding or cutting in paint booths, around dip tanks, degreasing, or other naturally hazardous areas.

d. Excessive or continued breathing of smoke, toxic fumes, or dust is injurious. Use respirator in addition to ventilation under severe conditions.

e. Keep all air in work area moving toward exhaust system.

2-18. Filler Metals

a. All stick electrodes for subject contract joints must be low hydrogen coated (herein called L.H.). L.H. electrode E-7018 (AWS Class.) is recommended, except when specially noted.

b. E-7019, E-8018, E-9018, E-10018, E-11018 have AC-DC polarity, reversing current, with a coating of low hydrogen iron powder.

c. L.H. electrodes are supplied from the vendor in hermetically sealed containers, and must have storage care normal to their type. If containers have been opened for electrodes to become exposed to normal (and above) atmospheric humidity, the electrodes should be oven baked at 700 °F. for 1 hour minimum.

d. L.H. electrodes which have been in water should be scrapped.

e. Remove only enough electrodes from the container to perform the immediate job. Open containers should be stored in heated storage containers held at 200° to 300°F.

f. The manufacturer employs little or no TIG production welding at the factory.

g. The manufacturer employs MIG welding extensively in production welding. Due to its nature however, the welding instruction herein (repair, as opposed to production welding) will deal only with stick electrodes. The precautionary and preparation instruction herein applies also to MIG or TIG welding.

2-19. Preparation

a. In natural ambient temperatures of 60 °F or less, the machine (or component) should be "room soaked" overnight in 70 °F (+) to equate a preheat. If this is impossible, the weld zone (area 6" to 10" each side) should be preheated to a minimum of 100 °F. before welding. This minimum temperature should be maintained on the heat zone of each joint until that joint is completed.

b. Thermal sticks may be used to check these weld heat-affected zones. Timpil sticks are available from welding suppliers in 50° increments from 100°F through 2200°F.

c. All cracks in the damaged area, or in areas listed in paragraph 2-14 above, must be groove-ground the entire length of the crack, and the entire crack removed. Any weld repair must be made on sound material.

d. No notches, gouges, or craters should be left in the area of weld repair, but must be weld-filled and ground to the original contour before repair welding. Preparation for weld assumes smooth surfaces and contours easily accessible to the weld arc.

e. Finish grind marks after welding (if any) on any surface should not exceed 63 microinches, and should run in the direction of the load. When required, a disc grinder with #80 grit abrasive is recommended.

2-20. Welding

a. Welding should be performed by experienced/qualified welders.

b. Voltage/amperage/speed settings should be balanced to produce a well-formed bead, and to assure proper penetration.

c. For subject component welding, the following ranges apply for E-7018, E-8018, E-9018 and E-10018 electrodes: Manufacturers recommendation for arc length and amperage is to be followed. These ranges must be balanced per *b* above.

Size	Amperage	Weld Inches Min (Average)
3/32	70-120	
1/8	100-150	6 - 8
5/32	120-200	8 - 10
3/16	200-275	10 - 12
7/32	275-350	12 - 14
1/4	300-400	14 - 16

d. On the rectifier type welders (most common today) the voltage is variable and is automatically keyed to the amperage. The voltage range is therefore omitted from the listing.

e. Average welding speed (inches per minute) is based on ¼" fillets and on flat and horizontal joints. It will be obvious that the selection of electrode sizes under 5/32" is unwise for this application.

f. All joints calling for 3/8" (or more) fillet must be made in 2 or more passes. Bead from first pass is to be chipped and work must not be allowed to cool between passes.

2-21. Inspection

a. Remove slag and spatter, and check for conformity to paragraph 2-20 (above). Finished and cooled joints should be thoroughly inspected for chill cracks. If any, prepare as in paragraph 2-19 (above) and reweld.

b. Joint inspection is recommended by either of the following methods:

(1) Dye penetrant, wet or dry process.

(2) Magnetic particle inspection. Manufacturer's instructions included with the testing gear should be followed as applied to the size, shape, or other nature of the work being tested. In general, however, the conditions shown below will serve in most cases, whether the process employs direct or rectified current.

(a) Distance betweeen prods shall not be less than 2 inches.

(b) Ratio for prod spacing/amperage/section thickness:

Spacing	Thickness Under 3/4"	Thickness over 3/4"
2" to 4"	200-300 amps	300-400 amps
4" to 6"	300-400 amps	400-600 amps
6" to 8"	400-600 amps	600-800 amps

(c) For circular magnetization using the direct method, care must be taken to provide sufficient contact area to pass the required amperage without overheating or burning the work. 100 to 400 amperes per inch of diameter should be used.

c. Continuous or residual inspection may be employed.

d. Repaired weldment should be checked for straightness, flatness, and overall conformance to original dimensions prior to returning to service.

2-22. Indemnity

It is understood by all parties that the welding repair of any damaged fork, carriage, or upright component on the machines of subject Government contract, and the compliance with the instructions and conditions contained herein, is to be the responsibility of the agency authorizing that repair, and not the manufacturer.

Section IV. REMOVAL AND INSTALLATION OF MAJOR COMPONENTS AND ACCESSORIES

2-23. General

The instructions in the following paragraphs are provided to aid in the removal and installation of those major components which are replaceable only at the Direct Support or higher level of maintenance. Refer to TM 10-3930-633-12 for removal and replacement instructions for those assemblies replaceable at organizational levels. Also observe the following special precautions.

a. Before attempting removal of any electrical component, make certain that the system is not energized. Disconnect battery ground strap.

b. Insure that adequate clearance is available for removal of the component. Disassemble the truck to the extent necessary to provide adequate working clearance.

c. Use a chain hoist, jack or other aid when lifting the heavier components. The lifting device should be positioned and attached to the component to remove all strain from the mounting hardware before the last of the hardware is removed.

d. To facilitate reassembly and installation, apply identifying tags to mating ends of electric or hydraulic lines as they are disconnected. Identify parts of similar configuration to insure correct reassembly.

e. To prevent moisture and foreign matter from entering open housings, lines, and other openings, apply protective covers as soon as practicable after disassembly.

2-24. Engine

a. Removal.

(1) Remove the two screws attaching the hood to the hinge brackets and remove the hood.

(2) Drain the cooling system and the engine crankcase (refer to TM 10-3930-633-12).

(3) Disconnect battery cable, and remove ground strap at engine connection point.

(4) Remove fan, fan belts, water pump pulley and upper and lower radiator hoses (see TM 10-3930-633-12).

(5) Remove radiator (see TM 10-3930-633-12).

(6) Disconnect the accelerator and choke cables from carburetor and anchor brackets on engine (refer to TM 10-3930-633-12). Disconnect hose at fuel pump.

(7) Remove air cleaner ductwork from carburetor (see TM 10-3930-633-12).

(8) Disconnect exhaust pipe from manifold (see TM 10-3930-633-12).

(9) Remove transmission oil filter (see figure 2-1) from bracket and position filter and hoses out of the way of engine removal. Remove clips from transmission oil lines.

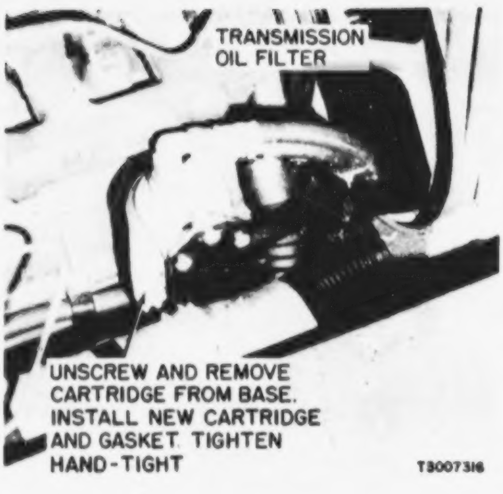

TRANSMISSION OIL FILTER
UNSCREW AND REMOVE CARTRIDGE FROM BASE. INSTALL NEW CARTRIDGE AND GASKET. TIGHTEN HAND-TIGHT
T3007316

Figure 2-1. Preparation for Engine Removal.

(10) Disconnect the engine wiring harness at the ignition coil, coolant temperature sending unit, oil pressure sending unit, and vacuum switch.

(11) Loosen and remove the alternator mounting bolts, and position alternator (with wiring attached) out of the way of engine removal.

(12) Raise the vehicle, using lifting eyes on the frame, and block securely under the frame for support.

(13) Remove the starter (see TM 10-3930-633-12) and the automatic transmission filler tube bracket.

(14) From underneath the vehicle, remove the converter housing access cover.

(15) Remove the nuts which attach the converter to the engine flywheel. Use of a wrench on the crankshaft pulley attaching bolt will enable the crankshaft to be turned until all nuts are removed.

(16) Block or brace the converter so that it will remain in the housing as the engine is removed.

(17) Refer to figure 2-2 and remove the front support frame bolt and nut. When engine is removed, insulators and washers may be removed.

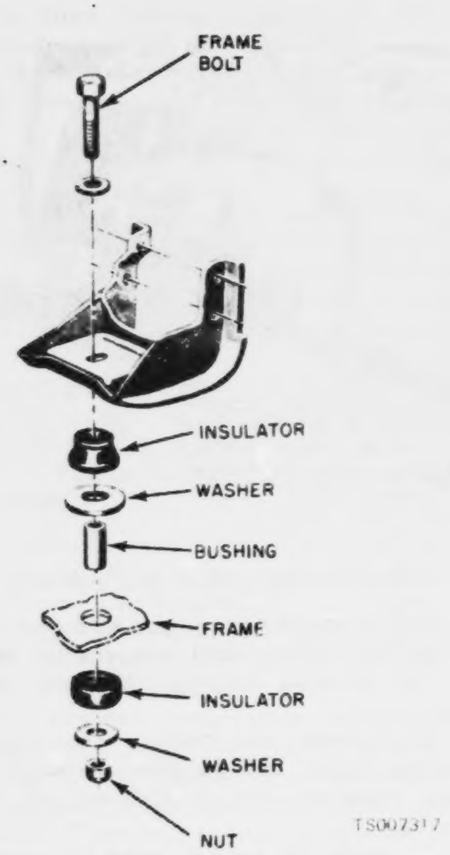


Figure 2-2. Engine Front Support.

(18) Attach a sling to the engine or lifting eyes, and tighten the hoist arrangement to bear most of the engine weight.

(19) Remove all converter housing to engine attaching screws. Raise the engine slightly and slide forward to disengage crankshaft from torque converter.

(20) Lift engine carefully and guide by hand to avoid striking parts of the engine against the frame. If any resistance is felt, stop hoist immediately and investigate cause before proceeding.

b. Installation.

(1) Place a new gasket on the muffler inlet pipe.

(2) Lower the engine carefully into place on the chassis. Make sure that front mount parts are arranged as shown in figure 2-2.

(3) Observe the engine to transmission converter housing flange and make sure that the converter pilot enters the crankshaft and that the dowel pins in the engine block engage the converter housing holes properly.

(4) Install engine to converter housing bolts. Lower engine fully on front support and remove lifting sling.

(5) Install frame bolt and nut through engine front support. Torque to 35 to 50 ft/lbs.

(6) Position the transmission oil filter assembly on the bracket as shown in figure 2-1, and install the three screws to secure filter to bracket. Install clips over oil lines on engine block.

(7) Install the starter (see TM 10-3930-633-12). Connect starter cables, and install the transmission filler tube bracket.

(8) Attach the exhaust pipe to the manifold flange. Torque the nuts to 25 to 35 ft/lbs.

(9) Connect the engine ground strap.

(10) Connect the vacuum line at the intake manifold. Connect the choke cable and accelerator cables to the carburetor and anchor brackets. Be sure the retracting spring is properly installed.

(11) Connect the engine wiring harness at the coil, vacuum switch, coolant temperature sender, and oil pressure sender.

(12) Install the alternator (see TM 10-3930-633-12) but do not tighten mounting bolts.

(13) Install radiator (see TM 10-3930-633-12). Connect oil cooler lines and install upper and lower radiator hoses.

(14) Install fan pulley, fan belts and fan. Torque fan bolts to 40 to 45 ft/lbs.

(15) Adjust fan belt tension and tighten alternator mounting bolts (see TM 10-3930-633-12).

(16) Install air cleaner ductwork. Connect hose to fuel pump.

(17) Install and adjust hood.

(18) Connect battery cables.

(19) Fill and bleed cooling system. Fill the engine crankcase (see TM 10-3930-633-12). Start the engine check for leakage. Adjust idle speed and mixture.

2-25. Transmission

a. Removal.

(1) Remove the screws along the floor plate, and lift off the transmission cover in the operator's compartment. Disconnecting the accelerator pedal will simplify removal of the transmission cover.

(2) Disconnect the parking brake link from the brake lever mechanism, and swing the transmission cover up and out of the way.

(3) Disconnect the push-pull control cable at the transmission linkage on the side of the transmission case. Remove locknuts from cable housing to free the cable from the anchor bracket (fig. 2-3).

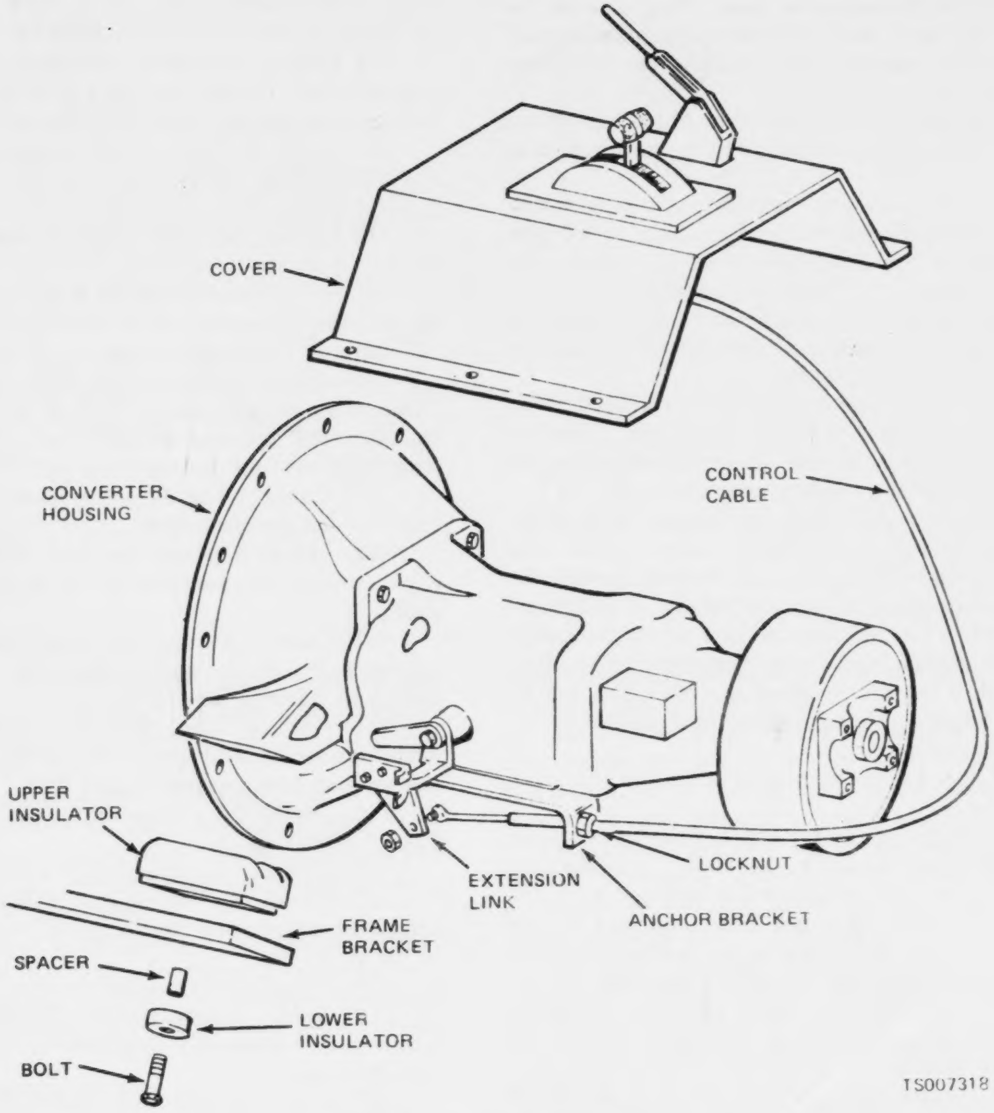

COVER
CONTROL CABLE
CONVERTER HOUSING
UPPER INSULATOR
EXTENSION LINK
LOCKNUT
ANCHOR BRACKET
FRAME BRACKET
SPACER
LOWER INSULATOR
BOLT
TS007318

Figure 2-3. Transmission Mounting.

(4) Raise the vehicle and block the frame securely.

(5) Place a drain pan under the transmission fluid pan. Starting at the rear of the pan and working toward the front, loosen the attaching bolts and allow the fluid to drain; finally remove all of the pan attaching bolts except two at the front, to allow the fluid to further drain. After the fluid has drained, install two bolts on the rear side of the pan to temporarily hold it in place.

(6) Remove the converter drain plug access cover from the lower end of the converter housing.

(7) Remove the converter-to-flywheel attaching nuts. Place a wrench on the crankshaft pulley attaching bolt to turn the converter to gain access to the nuts.

(8) With the wrench on the crankshaft pulley attaching bolt, turn the converter to gain access to the converter drain plug. Then, remove the plug. Place a drain pan under the converter to catch the fluid. After the fluid has drained from the converter, reinstall the plug.

(9) Wedge the converter to hold it in place when the transmission is removed.

(10) Disconnect the starter cable from the starter, and disconnect the transmission to body ground cable from the transmission. Remove the starter (see TM 10-3930-633-12).

(11) Disconnect oil cooler lines on the right side of the transmission case. Plug or seal the ports and hose ends to prevent contamination. Disconnect vacuum line at left rear of transmission.

(12) Remove the four nuts which attach the drive shaft companion flange to the parking brake drum.

(13) Support the transmission on a transmission jack. Secure the transmission to the jack with safety chain. Remove both engine rear support bolts.

(14) With the transmission jack, raise the engine and transmission high enough to remove the engine rear supports.

(15) Lower the engine against a floor stand or engine support bar so that the converter housing is clear of the crossmember when all weight is off the transmission jack.

(16) Remove the remaining converter housing-to-engine attaching bolts. Move the assembly toward the rear and lower it, leaving the flywheel attached to the crankshaft. If additional clearance is needed, tilt the rear of the assembly upright slightly and to the rear (enough to allow removal of the six flywheel to crankshaft bolts). Move tbe assembly to the rear, and remove it.

b. Installation.

(1) Torque the converter drain plug to 15 to 28 ft/lbs.

(2) If the converter has been removed from the converter housing, carefully position the converter to the transmission making sure the converter drive flats are fully engaged in the pump gear. Install a wedge to prevent the converter from slipping out of the housing.

(3) With the converter properly installed, place the transmission on the jack. Secure the transmission to the jack with safety chain.

(4) Rotate the converter so that the studs and drain plug are in alignment with their holes in the flywheel.

(5) Raise transmission and converter with the jack to align it with the engine. Remove the wedge from the converter housing. Carefully move the converter and transmission assembly forward into position, using care not to damage the flywheel and converter pilot. THE CONVERTER MUST REST SQUARELY AGAINST THE FLYWHEEL. THIS INDICATES THAT THE CONVERTER PILOT IS NOT BINDING IN THE ENGINE CRANKSHAFT.

(6) Install the lower converter housing-to-engine bolts. Torque the bolts to 40 to 50 ft/lbs. Remove the safety chain from the transmission.

(7) Raise the engine and transmission with the transmission jack, and remove the engine support stand or support bar.

(8) Install the rear support insulators as shown in figure 2-3.

(9) Lower the engine and transmission against the supports, and at the same time install the support bolts and torque to 20 to 30 ft/lbs.

(10) Install and torque the four converter-to-flywheel attaching nuts to 23 to 28 ft/lbs. Install the converter housing access cover and secure it with the attaching bolts at 12 to 16 ft/lbs.

(11) Connect the oil cooler inlet and outlet lines to the transmission.

(12) Install the vacuum line and retaining clips. Install the vacuum hoses on the vacuum unit.

(13) Coat the universal joint knuckle with transmission fluid, and install the companion flange to parking brake drum.

(14) Connect the push-pull cable to the extension lever, and secure the cable housing to the anchor bracket (see figure 2-3).

(15) Install the starter motor and cables (see TM 10-3930-633-12).

(16) Connect the fluid filler tube.

(17) Lower the vehicle and install the upper converter housing to engine bolts, and torque to 40 to 50 ft/lbs.

(18) Install transmission cover to floor plate.

(19) Refill transmission. Complete refill requires approximately 11 quarts of fluid (LO 10-3930-633-12).

(20) Start engine and check transmission and converter for leaks, and check general operation.

2-26. Rear Axle and Reduction Gearcase

a. Removal.

(1) Jack up, or hoist the entire vehicle high enough off the work surface to provide adequate working space underneath the frame for axle removal. See fig. 2-4.

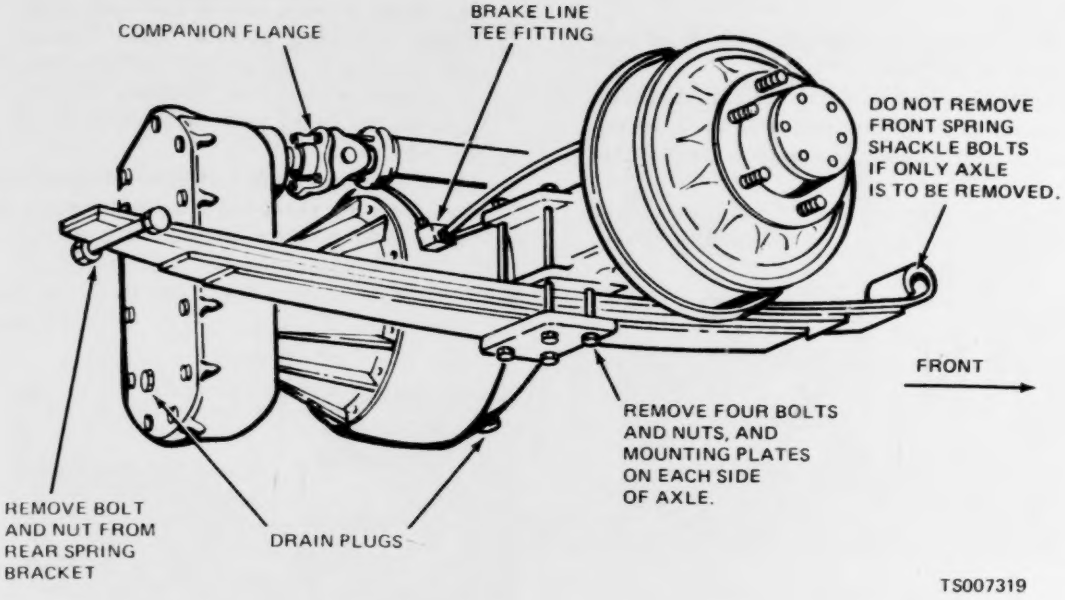

COMPANION FLANGE
BRAKE LINE TEE FITTING
DO NOT REMOVE FRONT SPRING SHACKLE BOLTS IF ONLY AXLE IS TO BE REMOVED.
FRONT
REMOVE FOUR BOLTS AND NUTS, AND MOUNTING PLATES ON EACH SIDE OF AXLE.
REMOVE BOLT AND NUT FROM REAR SPRING BRACKET
DRAIN PLUGS
TS007319

Figure 2-4. Rear Axle Removal.

(2) Support the vehicle, using adequate jack stands or blocking under the frame, making sure that the positioning of these supports will not interfere with axle removal.

(3) Remove rear wheels and tires.

(4) Disconnect hydraulic brake line from master cylinder at the tee fitting mounted next to the differential carrier. Plug the brake lines to prevent contamination.

(5) Remove differential and gearcase drain plugs and allow units to drain thoroughly.

(6) Remove the four nuts and disconnect the companion flange and flange yoke on the drive shaft.

(7) Position an axle jack, or similar device, under the axle housing to support the assembly once attaching hardware is removed. Adjust the supporting device to relieve strain from the mounting hardware.

(8) Remove the rear spring bolt and nut from the frame bracket at the rear of each spring.

(9) Remove the four bolts and lock nuts and the mounting plate from the axle spring mounting pad on each side.

(10) Lower the axle jack and axle, and remove from beneath the vehicle.

b. Installation.

(1) Position rear axle, with reduction gearcase assembled, under vehicle. The springs should be pushed down out of the way so that axle can be properly positioned.

(2) Raise the axle on the axle jack so that the springs can be rotated up into position. The free end (rearmost) of the springs should slide between the two frame brackets on each side.

(3) Install the two rear spring bracket bolts and locknuts, and tighten securely. Note that the bolt must be installed below the spring leaves to retain the free end of the spring.

(4) Carefully align the axle so that the center bolt of the spring fits into the recess under the spring pad on each side of the axle.

(5) Lower the axle so that it just rests on the springs.

(6) Position the spring plate (as shown in figure 2-4) and secure axle to springs by installing four bolts and locknuts on each side of the axle. Torque bolts to 50 to 60 ft/lbs.

(7) Connect brake line at tee fitting.

(8) Connect flange yoke on drive shaft to reduction gearcase companion flange and secure with four capscrews and nuts.

(9) Mount rear wheels and tires.

(10) Lower vehicle to the ground or floor, and fill the differential and reduction gearcase with the proper grade and type of lubricant for the season, as specified in LO 10-3930-633-12.

(11) Bleed the brakes. (Refer to TM 10-3930-633-12.)

2-27. Front Axle

a. Removal.

(1) Steam clean the area under the front axle and proceed as follows:

(2) Raise the vehicle, using the lifting eyes at the front and provide suitable sturdy blocking under the frame to support the vehicle during axle removal.

(3) If front wheels are to be removed, make certain to follow the procedures outlined below.

WARNING

The front wheels are of the split type. When removing wheels, make certain that tires are completely deflated and valve core is removed. Remove only the bolts on the inner bolt circle to demount the wheel.

(4) Disconnect drag link at steering arm ball stud by loosening threaded plug in drag link end. See figure 2-5.

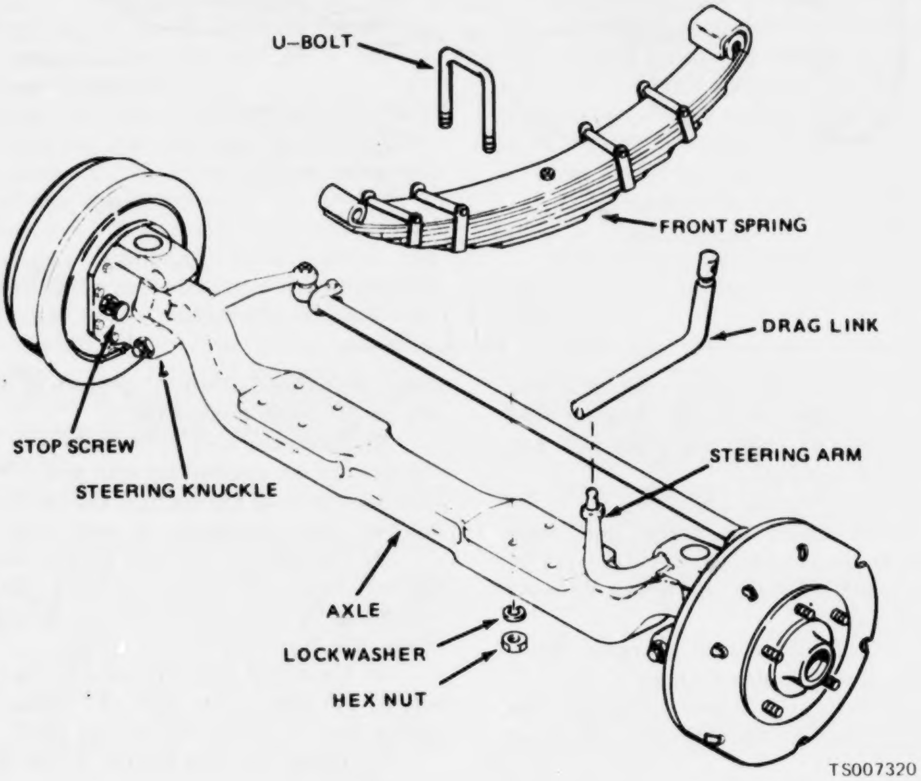


Figure 2-5. Front Axle Removal.

(5) Disconnect hydraulic brake lines at the wheel cylinders on each side. Plug the brake lines and cylinder ports to prevent contamination.

(6) Place an axle jack or other means of support under the axle.

(7) Remove the four hex nuts and lockwashers from the U-bolts under the spring pad on each side of the axle, and remove the axle from under the vehicle.

b. Installation.

(1) Place U-bolts over front springs (see figure 2-5).

(2) Support axle assembly so that it is held against springs while installing nuts and lockwashers.

(3) Before tightening U-bolt nuts and lockwashers, make certain that axle is positioned so that the spring center bolts enter recesses made into top of the axle spring seats. Torque nuts to 40 to 50 ft/lbs.

(4) Connect drag link to ball stud on the steering arm, and tighten threaded plug in the end of the drag link.

(5) Connect brake lines to wheel cylinders on each side of the axle.

(6) Install front wheels and tires. Inflate front tires to 100 PSI.

(7) Lower vehicle to the ground. Lubricate front axle (see LO 10-3930-633-12. Bleed the brake system. (Refer to TM 10-3930-633-12.)

(8) If axle has been repaired, adjust front wheel toe-in (see Chapter 12).

2-28. Vacuum Power Unit

a. Removal.

(1) Turn off engine and set parking brake.

(2) Raise hood and remove the left side hood panel, to expose the brake power unit as shown in figure 2-6.

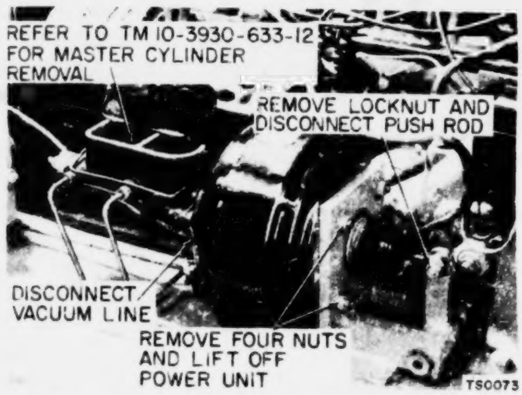

REFER TO TM 10-3930-633-12 FOR MASTER CYLINDER REMOVAL
REMOVE LOCKNUT AND DISCONNECT PUSH ROD
DISCONNECT VACUUM LINE
REMOVE FOUR NUTS AND LIFT OFF POWER UNIT
TS0073

Figure 2-6. Vacuum Power Unit Installation.

(3) Refer to TM 10-3930-633-12 and remove the master cylinder.

(4) Disconnect the vacuum line at the vacuum unit chamber.

(5) Remove the locknut and disconnect the vacuum unit pushrod.

(6) Remove the four hex nuts and lockwashers from the studs and lift off the vacuum power unit.

b. Installation.

(1) Position the vacuum unit against the mounting bracket, making certain that the vacuum hose connection is properly oriented. Install the four lockwashers and hex nuts to secure unit to bracket.

(2) Connect vacuum line.

(3) Refer to TM 10-3930-633-12 and install master cylinder.

(4) Connect pushrod to bellcrank and install locknut.

(5) Install left side hood.

(6) Bleed brakes and adjust pedal free travel. (Refer to TM 10-3930-633-12.)

2-29. Steering Gear.

a. Removal.

(1) Refer to figure 2-7 and disconnect steering gear from steering column by removing capscrews and nuts through the flexible coupling.

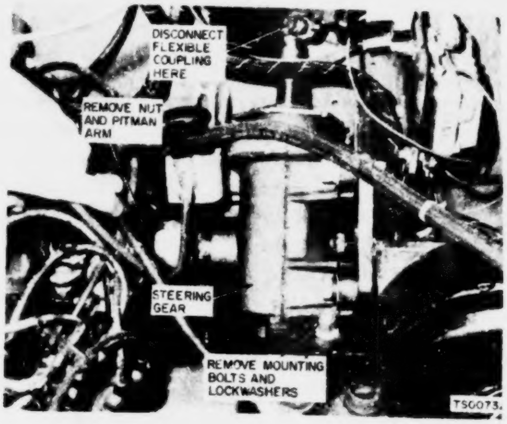

DISCONNECT FLEXIBLE COUPLING HERE
REMOVE NUT AND PITMAN ARM
STEERING GEAR
REMOVE MOUNTING BOLTS AND LOCKWASHERS
TS0073

Figure 2-7. Steering Gear Mounting.

(2) Remove nut on pitman arm shaft and work pitman arm off the shaft. Pitman arm may be disconnected from drag link by loosening threaded plug in the end of the drag link until the pitman arm ball stud will pull free of the drag link socket.

(3) Remove the three steering gear mounting bolts, and lift out the steering gear.

b. Installation.

(1) Install the steering gear to the mounting bracket as shown in figure 2-7, and secure with three mounting bolts.

(2) Refill steering gear with the type and grade of lubricant specified in LO 10-3930-633-12.

(3) Align flexible coupling halves at the base of the steering column and install the two capscrews and nuts to secure the coupling.

(4) Position the steering gear in the center of its travel. Rotate the input shaft slowly from lock-to-lock and back it off one-half the total travel.

(5) With the gear at its midpoint, install the pitman arm so that it is centered in its travel between the stop screws. Secure the pitman arm by installing and tightening the locknut on the end of the pitman arm shaft.

(6) Connect pitman arm to drag link, and, if necessary, adjust drag link length as outlined in TM 10-3930-633-12.

CHAPTER 3

REPAIR OF ELECTRICAL SYSTEM

Section I. ALTERNATOR

3-1. General

The alternator is an A.C. (alternating current) generator which delivers relatively high output of energy at low speeds. The physical characteristics of the design are discussed below.

a. Operation. The unit consists of a rotating field coil, called the rotor, which is supported by bearings and rotates, being driven by the engine, inside an electromagnetic field generated by the stator windings. The stator windings are attached to the alternator frame. Brushes in the unit pick up the oscillating current from the rotor, and pass it through a set of diode rectifiers in the alternator end frame to produce a D.C. (direct current) output. A voltage regulator is used with the alternator to control the strength of the electrical fields, and therefore the relative values of the output.

b. Rotor. The rotor consists of one continuous electrical winding on the rotor shaft. The shaft is supported by a ball bearing at the drive end and a needle roller bearing at the brush end. The bearings are provided with grease reservoirs, eliminating the need for periodic lubrication.

c. Stator and Frame. Stator windings are assembled on the inside of a laminated core that forms part of the frame. Six rectifier diodes are assembled into the slipring end frame and are connected to the stator windings.

d. Brushes. Two brushes are used to carry current from the regulator circuit, through the sliprings, to the rotor field coil. Brushes are extra long for extended service.

3-2. Service Precautions

Since the a.c. generator and regulator are designed for use on only one polarity system, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to the electrical equipment.

a. When installing a battery, always make absolutely sure the ground polarity of the battery and the ground polarity of the a.c. generator are the same.

b. When connecting a booster battery. make certain to connect the negative battery terminals together and the positive battery terminals together.

c. When connecting a charger to the battery, connect the charger positive lead to the battery positive terminals and the charger negative lead to the battery negative terminal.

d. Never operate the a.c. generator on open circuit. Make absolutely certain all connections in the circuit are secure.

e. Do not short across or ground any of the terminals on the a.c. generator or regulator.

f. Do not attempt to polarize the a.c. generator.

g. Always disconnect alternator before doing any repair welding, to prevent reverse current damage.

3-3. Maintenance

a. While the a.c. generator is constructed to give long periods of service, a regular inspection procedure should be followed to obtain its maximum life. The frequency of inspection is determined largely by operating conditions. High speed operation, high temperatures, dust, and dirt all increase the wear on brushes, sliprings, and bearings.

b. At regular intervals inspect terminals for corrosion and loose connections and wiring for frayed or deteriorated insulation. Check mounting bolts for tightness and belt for alignment, proper tension and wear. When tightening belt tension, apply pressure against the stator laminations between end frames and not against either end frame.

c. Noise from an a.c. generator may be caused by worn or dirty bearings, loose mounting bolts, loose drive pulley, defective diode or defective stator.

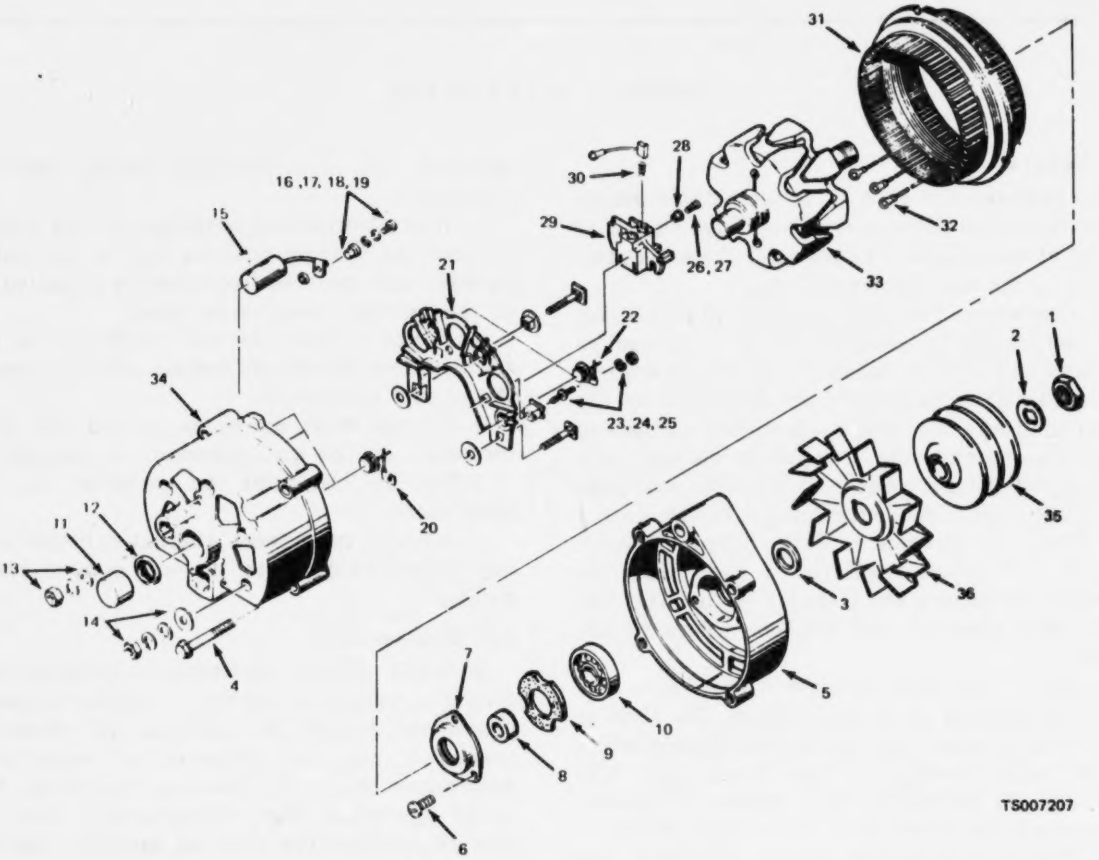
3-4. Alternator Repair

a. General. If the a.c. generator is new but suspected of being faulty, a generator output test should be performed before removing the unit from engine. See TM 10-3930-633-12 for procedure. After extended periods of operation however, or at time of engine overhaul, the generator should be removed for a thorough inspection and cleaning.

b. Removal. Refer to TM 10-3930-633-12.

c. Disassembly.

(1) Refer to figure 3-1 for parts identification and proceed as follows:



1. Nut
2. Washer
3. Collar
4. Through bolt
5. Drive end frame
6. Screw
7. Bearing cap
8. Collar
9. Gasket
10. Bearing
11. Bearing
12. Retainer
13. Ground terminal package
14. Battery terminal package
15. Capacitor
16. Screw
17. Washer
18. Washer
19. Insulator
20. Diode
21. Heat sink
22. Diode
23. Terminal package
24. Terminal nut
25. Washer
26. Screw
27. Lockwasher
28. Insulator
29. Brush
30. Spring
31. Stator
32. Terminal
33. Rotor
34. Frame
35. Pulley
36. Fan

Figure 3-1. Alternator Assembly.

(2) Remove the four through bolts (4). Separate the drive end frame (5) and rotor assembly (33) from the stator (31) by prying apart with a screwdriver at the stator slot. A scribe mark should be made on the parts to aid in positioning at reassembly.

(3) Place a piece of tape over the slipring end frame bearing (11) to prevent entry of dirt.

(4) To remove the drive end frame from the rotor, place the rotor in a vise and tighten only enough to permit removal of the shaft nut (1).

CAUTION

Avoid excessive tightening as this may cause distortion of the rotor.

(5) Remove the shaft nut (1), washer (2), pulley (35), fan (36) and the collar (3), and then separate the drive end frame (5) from the rotor shaft.

(6) Further disassembly should be performed only as necessary, as outlined in the following subparagraphs.

d. Rotor Checks. The rotor must be checked electrically for grounded, open, or short circuited field coils, using an ohmmeter as shown in figure 3-2.

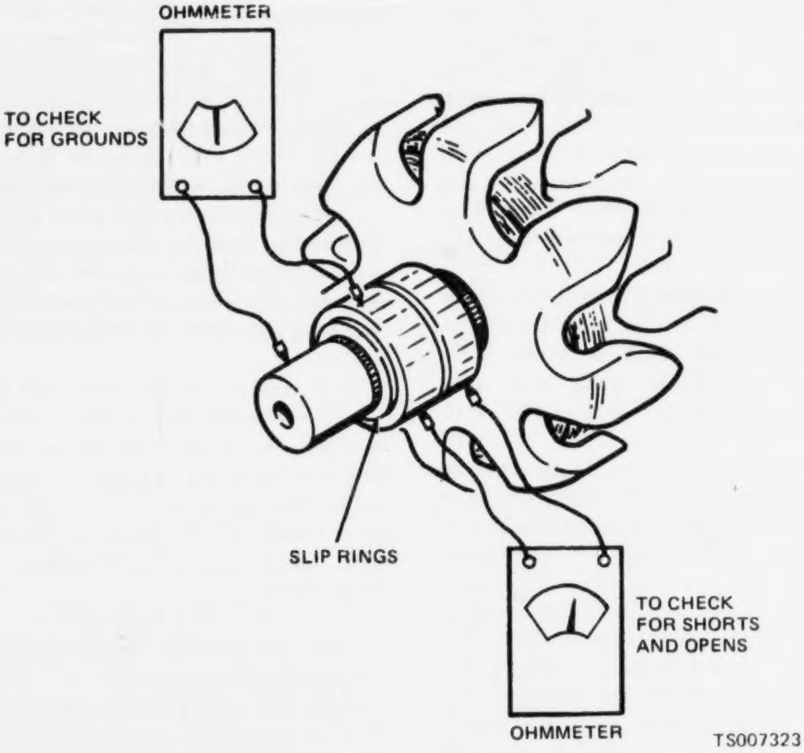


Figure 3-2. Rotor Checks.

(1) To check for grounds, connect a 110-volt test lamp or an ohmmeter from either slipring to the rotor shaft or to the rotor poles. If the lamp lights, or if the ohmmeter reading is low, the field winding is grounded.

(2) To check for opens, connect the test lamp or ohmmeter to each slipring. If the lamp fails to light, or if the ohmmeter reading is high (infinite), the winding is open.

(3) The winding is checked for short circuits by connecting a battery and ammeter in series with the two sliprings. Note the ammeter reading and refer to specifications. An ammeter reading above the specified value indicates shorted windings. An alternate method is to check the resistance of the field by connecting an ohmmeter to the two sliprings. If the resistance reading is below the specified value, the winding is shorted. The specified resistance value can be determined by dividing the voltage by the current given in Tabulated Date, paragraph 1-8.

(4) Replace the rotor if any of these checks reveal a defect.

e. Stator Checks. To check the stator windings, remove all three stator lead attaching nuts and then separate the stator assembly from the end frame. The fit between stator frame and end frame is not tight, and the two can be separated easily.

(1) The stator windings may be checked with a 110-volt test lamp or an ohmmeter. If the lamp lights, or if the meter readings is low when connected from any stator lead to the frame, the windings are grounded. If the lamp fails to light, or if meter reading is high when successively connected between each pair of stator lead, the windings are open.

(2) A short circuit in the stator windings is difficult to locate without laboratory test equipment due to the low resistance of the windings. However, if all other electrical checks are normal and the generator fails to supply rated output, shorted stator windings are indicated.

f. Diode Checks. One method of checking diodes is to use an ordinary ohmmeter. The lowest range scale on the ohmmeter should be used and the ohmmeter should have a 1½ volt cell. To determine the cell voltage, turn the selector to the lowest scale, and then connect the ohmmeter leads to a voltmeter. The voltmeter will indicate the cell voltage.

(1) With the stator disconnected, check a diode in the heat sink by connecting one of the ohmmeter leads to the heat sink, and the other ohmmeter lead to the diode lead, and note the reading. Then reverse the ohmmeter lead connections and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the heat sink in the same manner.

(2) To check a diode mounted in the end frame, connect one of the ohmmeter leads to the end frame, and the other ohmmeter lead to the diode lead and note the reading. Then reverse the ohmmeter lead connections, and note the reading. If both readings are very low, or if both readings are very high, the diode is defective. A good diode will give one low reading and one high reading. Check the other two diodes in the end frame in the same manner.

g. Diode Replacement.

(1) Diodes are pressed into the end frame and heat sink. To remove diodes, use a piece of tubing slightly larger than the diode to support the heat sink or end frame, while pressing out the old diode.

(2) When pressing in a new diode, use a piece of thin-wall tubing that will contact only the outer rim of the diode, to press the diodes in place. Support the heat sink and end frame with a larger piece of tubing as before.

(3) Positive diodes are marked with red printing, negative diodes with black. If all diodes are replaced, be sure that positive diodes are installed in heat sink and negative diodes installed in end frame.

CAUTION

Do not strike any of the diodes while removing. Shock may cause damage to the other good diodes.

h. Slipring Servicing.

(1) If the springs are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin the rotor in a lathe, or otherwise spin the rotor, and hold the polishing cloth against the sliprings until they are clean.

CAUTION

The rotor must be rotated in order that sliprings will be cleaned evenly. Cleaning the sliprings by hand without spinning the rotor may result in flat spots on the sliprings, causing brush noise.

(2) Sliprings which are rough or out-of-round should be trued in a lathe to .002 inch maximum indicator reading. Remove only enough material to make the rings smooth and round. Finish with 400 grain or finer polishing cloth and blow away all dust.

i. Bearing Replacement and Lubrication.

(1) The bearing in the drive end frame can be removed by detaching the retainer plate screws and then pressing the bearing from the end frame. If the bearing is in satisfactory condition, it may be re-used, and it should be filled one-quarter full with special grade ball bearing lubricant before reassembly.

CAUTION

Do not overfill, as this may cause the bearing to overheat.

(2) To install a new bearing, press in with a tube or collar that just fits over the outer race. It is recommended that a new retainer plate be installed if the felt seal in the retainer plate is hardened or excessively worn.

(3) The bearing in the slipring end frame should be replaced if its grease supply is exhausted. No attempt should be made to relubricate and re-use the bearing. To remove the bearing from the slipring end frame, press out with a tube or collar that just fits inside the end frame housing. Press from the outside of the housing towards the inside.

(4) To install a new bearing, place a flat plate over the bearing and press in from the outside towards the inside of the frame until the bearing is flush with the outside of the end frame. Support the inside of the frame with a hollow cylinder to prevent breakage of the end frame. Use extreme

care to avoid misalignment or otherwise placing undue stress on the bearing.

(5) Saturate the felt seal with S.A.E. 20 oil, and then reassemble the felt seal and steel retainer.

j. Brush Replacement.

(1) When the slipring end frame assembly is separated from the rotor and drive end frame assembly, the brushes will fall down onto the shaft and come in contact with the lubricant. If the brushes are to be re-used, they must be thoroughly cleaned with a soft dry cloth. Also, the shaft must be thoroughly cleaned before reassembly.

(2) The brush springs should be inspected for any evidence of damage or corrosion. If there is any doubt as to the condition of the brush springs, they should be replaced.

(3) To install new brushes, remove the brush holder assembly from the end frame by detaching the two brush holder assembly screws. Install the springs and brushes into the brush holder, and insert a straight wire or pin into the holes at the bottom of the holder to retain the brushes. Then attach the brush holder assembly onto the end frame, noting carefully the proper stack-up of parts as shown in figure 3-3. Allow the straight wire to protrude through the hole in the end frame.

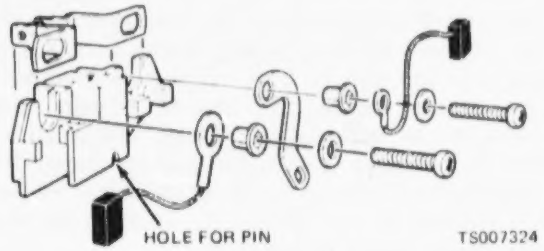


Figure 3-3. Brush Holder Assembly.

k. Heat Sink Replacement. The heat sink may be replaced by removing the "BAT" and "GRD" terminals from the end frame, and the screw attaching the condenser lead to the heat sink. During reassembly, note carefully the proper stack-up of parts as shown in figure 3-4.

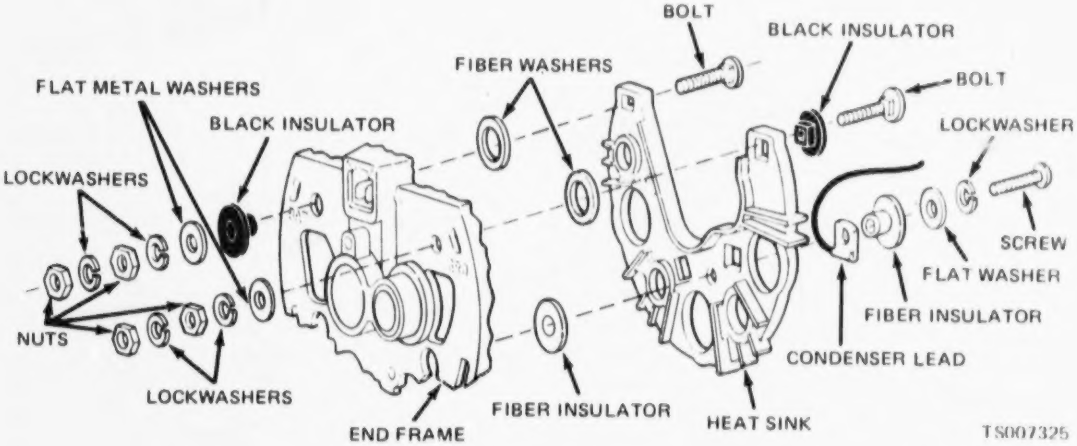


Figure 3-4. Heat Sink.

l. Reassembly. Reassemble the alternator as shown in the exploded view (fig. 3-1). Note the following procedures:

(1) Hold rotor with hex key wrench in end of shaft and tighten pulley nut to 60 ft/lbs. If pulley is held in vise and excessive pressure is applied against rotor, the assembly may become distorted.

(2) When installing slipring end frame assembly to rotor and drive end frame assembly, remove tape over the bearing and shaft. Make sure shaft is perfectly clean.

(3) Insert a straight wire as previously mentioned through holes in brush holder and end frame to retain the brushes. Remove the wire after the a.c. generator has been completely assembled. The brushes will then drop into place on sliprings.

m. Installation and Testing. Refer to TM 10-3930-633-12 for installation and testing procedures.

Section II. STARTER

3-5. General

The starter is a 12-volt motor that has the solenoid mounted on the starter housing. The solenoid is energized when the starter relay contacts are closed. This action engages the starter drive with the flywheel ring gear, starting the engine. An overrunning clutch in the drive protects the starter from excessive speed when the engine starts. The starter current flows through the solenoid energizing coil until the solenoid plunger is at the end of its travel. The plunger then closes a set of contacts that by-pass the energizing coil, letting the holding coil keep the starter drive engaged.

3-6. Starter Repair

a. Removal. Refer to TM 10-3930-633-12 for complete removal instructions.

b. Disassembly. Refer to figure 3-5 for parts identification, and proceed as follows, after cleaning the outside of the starter thoroughly.

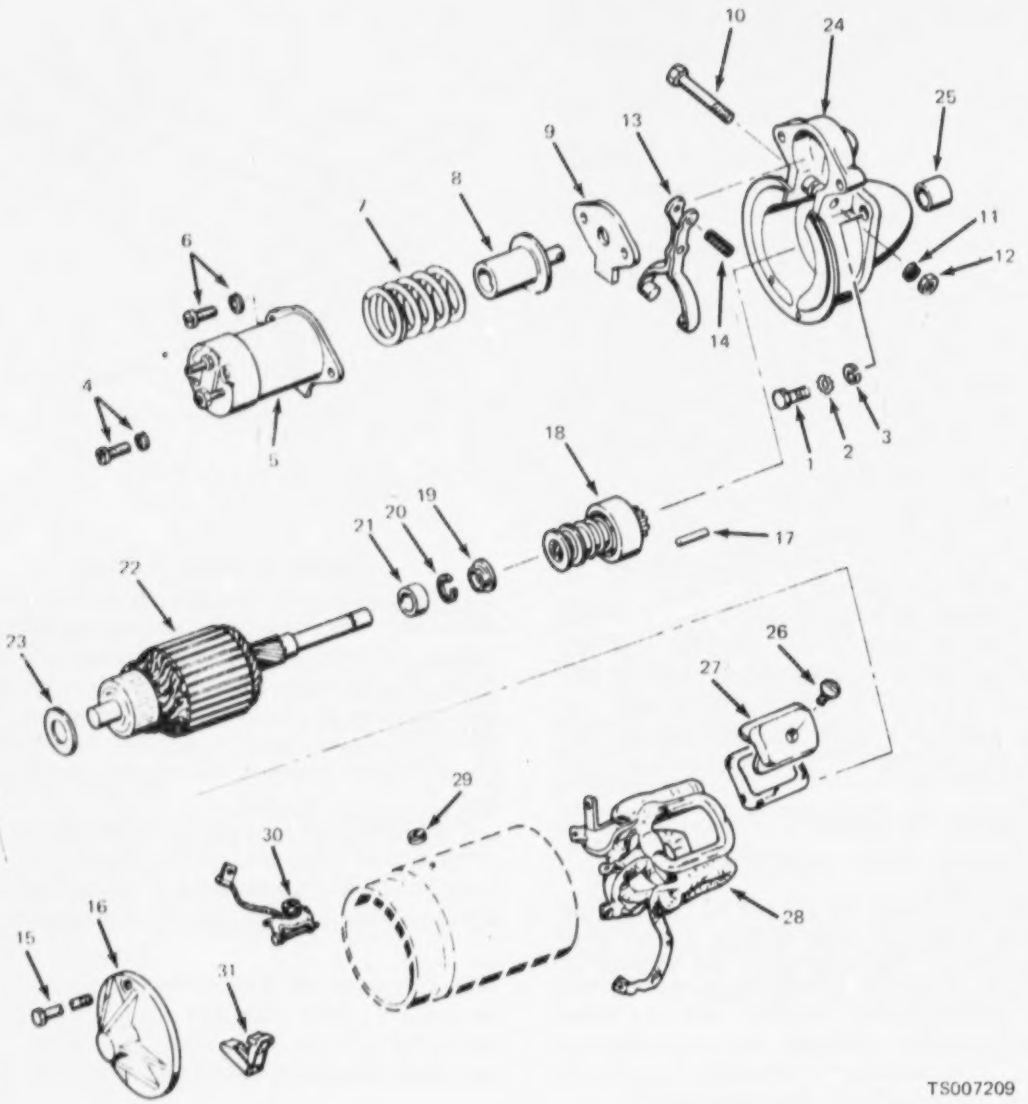
(1) Disconnect the field coil connections from the solenoid motor terminal.

(2) Remove the through bolts (15).

(3) Remove the commutator end plate (16) and field frame assembly.

(4) Remove the armature assembly (22) from the drive housing (24). It will be necessary to remove the solenoid (5) and shift lever assembly (13) from the drive housing before removing the armature assembly.

(5) Remove the thrust collar (19) from the armature shaft.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TS007209

1. Screw
2. Lockwasher
3. Lockwasher
4. Field lead screw
5. Solenoid
6. Screw
7. Plunger spring
8. Plunger
9. Switch seal
10. Bolt
11. Washer
12. Nut
13. Lever
14. Pivot pin
15. Through bolt
16. Commutator end plate
17. Dowel pin
18. Drive pinion assembly
19. Collar
20. Retaining ring
21. Collar
22. Armature
23. Thrust washer
24. Drive end housing
25. Bushing
26. Pole shoe screw
27. Pole shoe
28. Field coils
29. Grommet
30. Brush support set
31. Brush set

Figure 3-5. Starter Assembly.

(6) Remove the pinion from the armature by sliding a metal cylinder onto the shaft; with a hammer striking the metal cylinder against the retainer, drive the retainer toward the armature core and off the snap ring (20).

(7) Remove the snap ring (20) from the groove in the armature shaft.

(8) Roll type drive pinion assemblies (18) are designed to be serviced as a complete unit; therefore, do not disassemble. If the condition of the clutch assembly is questionable, replace it.

(9) A pole shoe spreader and pole shoe screwdriver should be used if the field coils are to be removed. Extra caution should be taken in replacing the field coils to prevent grounding or shorting when they are tightened in place. If the pole shoe has a long lip on one side, it should be assembled in the direction of armature rotation.

c. *Inspection and Repair.*

(1) Inspect the brushes for wear. If they are worn down to one-half their original length, when compared with a new brush, they should be replaced. New brushes are ½ inch long.

(2) Clean brush holders and be sure that the brushes will not bind in the holders. The full length of the brush surface should ride on the commutator with the proper spring tension (40 ounces) to provide a good contact. Inspect the brush leads and screws to be sure they are tight and clean.

(3) Inspect the armature to be sure there are no short circuits, opens, or grounds (see steps 4, 5 and 6 following).

(4) Short circuits are located by turning the armature in a growler while holding a steel strip on the armature. The steel strip will vibrate on the area of the short circuit. See figure 3-6.

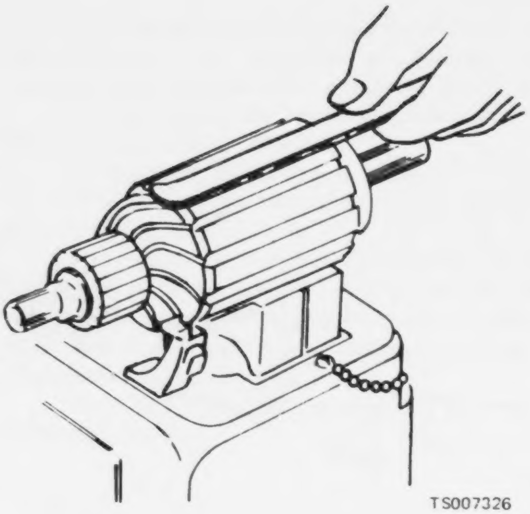


Figure 3-6. Testing for Shorts.

(5) Opens are usually found where the conductors are joined to the commutator. Loose or poor connections will cause arcing and burning of the commutator. If the bars are not burned too bad, resolder the leads in the riser bars and turn the commutator down in a lathe. Then undercut the insulation between the commutator bars 1/32 inch.

(6) Grounds in the armature can be found using a test lamp and prods, figure 3-7. If the lamp lights when one prod is positioned on the armature core or shaft, the armature is grounded.

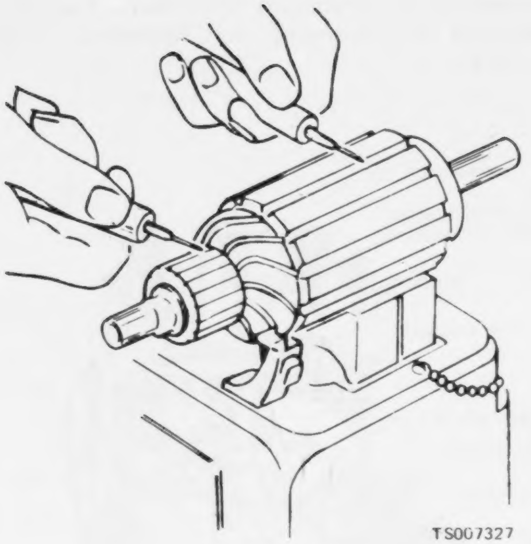


Figure 3-7. Testing for Grounds.

(7) Check field coils with a 12-volt test lamp as outlined in steps 8 and 9.

(8) With the field coil ground disconnected, position one test prod on the field frame and the other to the field connector. If the lamp lights, the field coils are grounded and must either be replaced or repaired.

(9) If the test lamp does not light when the prods are connected to the ends of coil leads, the field coils are open.

d. Reassembly. Refer to figure 3-5.

(1) Place the drive pinion assembly (18) on the armature shaft.

(2) To aid in reinstalling the snap ring (20) and collar (21) on the armature shaft, proceed as follows. Place the collar (21) on the armature shaft with the cupped surface facing the snap ring groove.

(3) Place the snap ring (20) on the end of the shaft. With a piece of wood on top of ring, force the ring over the shaft with a light hammer blow, then slide the ring down into the groove.

(4) To force the retainer over the snap ring, place a suitable washer over the shaft and squeeze the retainer and washer together with pliers.

(5) Remove the washer.

(6) Lubricate bearing of drive housing (24) with silicon grease and install armature and drive assembly in housing.

CAUTION

Do not lubricate solenoid plunger or solenoid cylinder.

(7) Install return spring (7) on solenoid plunger (8) and insert plunger into solenoid cylinder. Apply sealing compound on both sides of solenoid flange where it extends between drive housing and field frame. Attach plunger to shift lever (13) with fulcrum pin (14). Fasten solenoid to drive housing with two mounting screws (6).

(8) If field coils were removed from field frame, position coils of replacement field coil assembly (28) on pole shoes and mount each pole shoe (27) in field frame with a pole shoe screw (26). Use care in tightening screws to avoid distortion of parts. Be certain that screws are securely tightened. Insert ends of field coil leads through rubber grommet in field frame.

(9) Position field frame assembly over armature assembly so that its down pin (17) engages the hole in drive housing. Use care to prevent damage to brushes and brush holders. Make sure that brushes (31) are properly seated on commutator.

(10) Install leather thrust washer (23) on commutator end of armature assembly. Lubricate bearing in commutator end frame with silicon grease and position end frame to field frame so that armature shaft enters bearing. Secure field frame and end frame to drive housing with two through bolts (15). Connect field leads to motor terminal of solenoid with screw (4).

e. Installation and Testing. Refer to TM 10-3930-633-12 for procedures covering installation and testing of the starter assembly.

Section III. IGNITION DISTRIBUTOR

3-7. General

The distributor is equipped with both vacuum and centrifugal advance units. The vacuum advance governs the ignition timing (spark advance) during low engine speeds (RPM) or low engine loadings. The centrifugal advance, in combination with the vacuum advance, controls the ignition timing at higher engine speeds or heavy engine loadings to provide the correct ignition timing for maximum engine performance. The advance mechanisms are independently operated.

a. Centrifugal Advance. The centrifugal advance mechanism (fig. 3-8) is located below the

stationary subplate assembly and has centrifugal weights that move inward or outward with changes in engine speed. As engine speed increases, the centrifugal weights move ahead with respect to the distributor drive shaft. The rate of advance is controlled by calibrated weight springs.

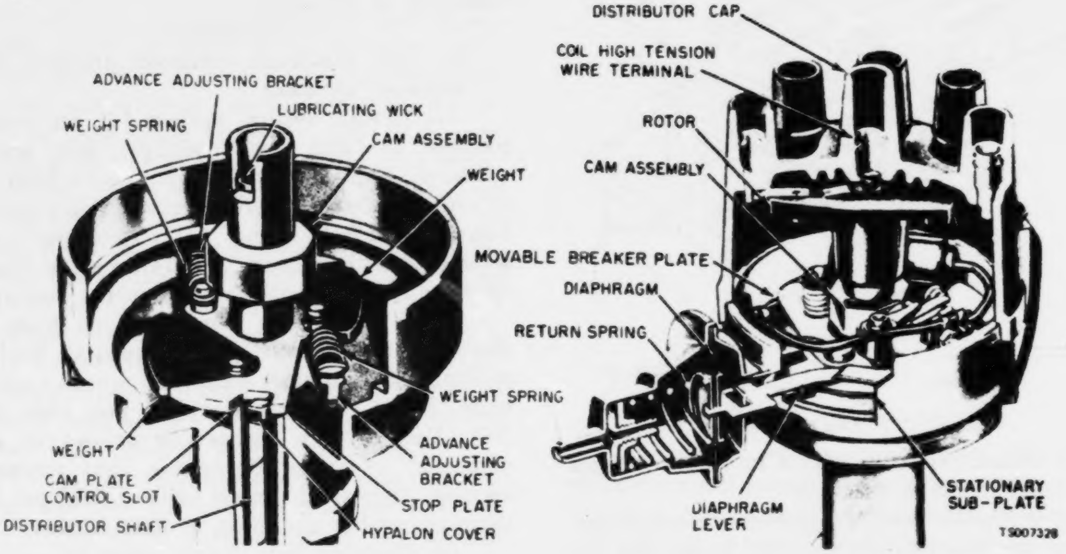

ADVANCE ADJUSTING BRACKET
WEIGHT SPRING
LUBRICATING WICK
CAM ASSEMBLY
WEIGHT
WEIGHT SPRING
ADVANCE ADJUSTING BRACKET
STOP PLATE
HYPALON COVER
WEIGHT
CAM PLATE CONTROL SLOT
DISTRIBUTOR SHAFT
DISTRIBUTOR CAP
COIL HIGH TENSION WIRE TERMINAL
ROTOR
CAM ASSEMBLY
MOVABLE BREAKER PLATE
DIAPHRAGM
RETURN SPRING
DIAPHRAGM LEVER
STATIONARY SUB-PLATE
TS007328

Figure 3-8. Distributor Cutaway.

b. *Vacuum Advance.* **The vacuum single advance has a spring loaded diaphragm connected to the breaker plate assembly. The diaphragm is moved against the spring pressure by vacuum pressures. When the vacuum increases, the diaphragm causes the movable breaker plate to pivot on the stationary sub-plate. The breaker point rubbing block, which is positioned on the opposite side of the cam from the pivot pin, then moves opposite to distributor rotation and advances the spark timing. As the movable breaker plate is rotated from retard position to full-advance position, the breaker point dwell will remain constant due to the breaker point rubbing block and the cam rotating on the same axes of the breaker plate and sub-plate.**

3-8. Distributor Repair

a. *Removal.* **See TM 10-3930-633-12 for distributor removal procedures.**

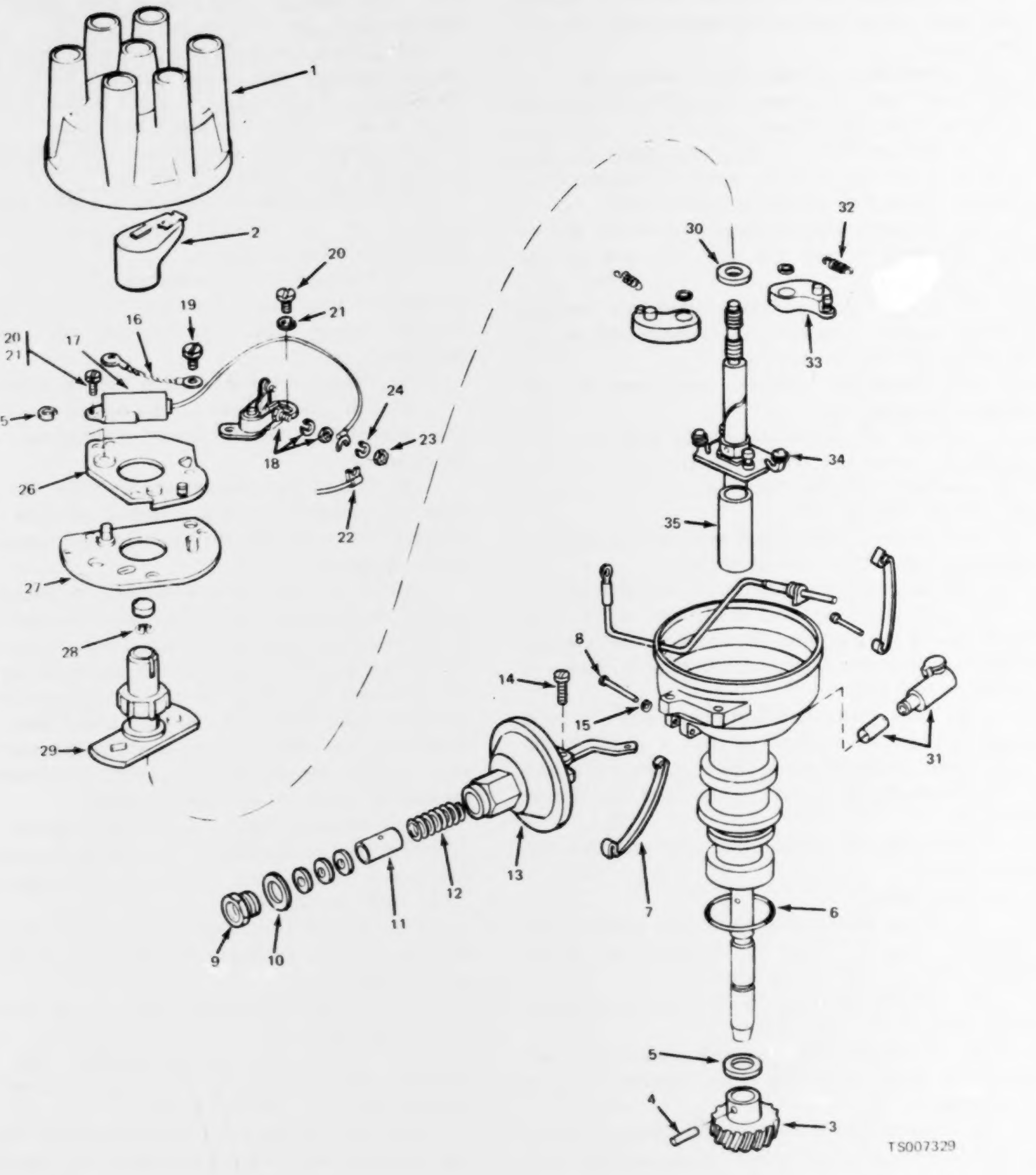
b. *Disassembly.* **Refer to figure 3-9 for parts identification, and proceed as follows:**

(1) Unsnap clamps (7) and remove cap (1) and rotor (2).

(2) Disconnect the primary wire (22) and the condenser wires from the contact point assembly (18).

(3) Remove the contact point assembly retaining screws (19 and 20) and the condenser or ground wire retaining screw. Lift the breaker point assembly and condenser (if so equipped) out of the distributor.

(4) Remove the spring clip that secures the diaphragm link to the movable breaker plate.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1. Distributor cap
2. Rotor
3. Gear
4. Pin
5. Spacer
6. Seal ring
7. Clamp
8. Pin
9. Vacuum connector
10. Gasket
11. Stop
12. Spring
13. Diaphragm assembly
14. Screw
15. Washer
16. Ground wire
17. Condenser
18. Contact point set
19. Screw
20. Screw
21. Washer
22. Primary wire
23. Nut
24. Washer
25. Spring clip
26. Movable breaker plate
27. Stationary sub-plate
28. Retainer
29. Cam
30. Thrust washer
31. Oiler
32. Springs
33. Weights
34. Shaft assembly
35. Bushing

Figure 3-9. Distributor Assembly.

(5) Remove the diaphragm retaining screws (14) and slide the diaphragm out of the distributor.

(6) Working from the inside of the distributor, pull the primary wire (22) through the opening in the distributor.

(7) Remove the spring clip (26) the flat washer and the spring washer securing the breaker plate (26) to the sub-plate (27).

(8) Remove the sub-plate retaining screws and lift both plates (26 and 27) out of the distributor.

(9) Mark one of the distributor weight springs and its brackets. Also mark one of the weights and its pivot pin.

(10) Carefully unhook and remove the weight springs (32).

(11) Lift the lubricating wick from the cam assembly. Remove the cam retainer (28). Lift the cam assembly off the distributor shaft. Remove the thrust washer (30).

(12) Remove the weight retainers and lift the weights (33) out of the distributor.

(13) Remove the distributor cap clamps (7).

(14) If the gear and shaft are to be used again, mark the gear and the shaft so that the pin holes can be easily aligned for assembly. Remove the gear roll pin (4).

(15) Invert the distributor and place it on a support plate in a position that will allow the distributor shaft to clear the support plate and press the shaft out of the gear and the distributor housing.

(16) Remove the oil filler cap and the felt wick (31).

c. *Inspection.*

(1) Check distributor shaft and bushing for signs of wear. If wear is evident, the entire distributor should be replaced.

(2) Check gear carefully for worn or damaged teeth. Replace a worn gear.

(3) Check breaker and sub-plates to make sure they fit properly and work without sticking or binding.

(4) Use new point set and condenser, rotor, and distributor cap when reassembling the distributor.

(5) Replace primary wire if it is burned, chafed, or corroded.

d. *Reassembly.* See figure 3-9.

(1) Oil the shaft and slide it into the distributor body.

(2) Place the assembly in a vise or press and install gear (3) on shaft using a piece of tubing sized to slide over shaft and bear against gear hub. Press gear on until hole in gear aligns with hole in shaft for installation of pin (4).

(3) Check the shaft end play with feeler gage placed between the collar and the base of the distributor. If the end play is not within 0.003 to 0.010 inch, replace the shaft and gear.

(4) Remove the distributor from the press. Install the gear retaining pin (4).

(5) Position the distributor in a vise. Fill the grooves in the weight pivot pins with a distributor cam lubricant.

(6) Position the weights (33) in the distributor (the marked weight is placed on the marked pivot pin) and install the weight retainers.

(7) Place the thrust washer (30) on the shaft.

(8) Fill the grooves in the upper portion of the distributor shaft with distributor cam lubricant.

(9) Install the cam assembly (29). Be sure that the marked spring bracket on the cam assembly is near the marked spring bracket on the stop plate.

(10) If a new cam assembly is being installed, make sure that the hypalon covered stop is in the correct cam plate stop. This can be done by measuring the length of the slot used on the old cam and by using the corresponding slot on the new cam. Some of the cams will have the length of the slot in degrees stamped near the slot. If the wrong slot is used, an incorrect maximum advance will be obtained.

(11) Place a light film of distributor cam lubricant on the distributor cam lobes. Install the retainer and the wick. Saturate the wick with SAE 10W engine oil.

(12) Install the weight springs (32). Be sure that the marked spring is attached to the marked spring brackets.

(13) Place the breaker plate (26) in position on the sub-plate (27).

(14) Install the spring washer, the flat washer, and the spring clip that secures the breaker plate to the sub-plate.

(15) Install the sub-plate hold-down screws (the ground wire should be under the sub-plate hold-down screw near the primary wire opening in the distributor).

(16) Working from the inside of the distributor, push the primary wire (22) through the opening in the distributor.

(17) Slide the diaphragm (18) into the opening in the distributor and place the link in its position.

(18) Install the spring clip that secures

diaphragm link to the movable breaker plate and install the diaphragm retaining screws (14).

(19) Place the contact point assembly (18) and the condenser (17) in position and install the retaining screws (19, 20 and 21). Be sure to place the ground wire (16) under the condenser retaining screws.

(20) Connect the primary wire (22) and the condenser lead to the contact point assembly.

(21) Install the rotor (2) and the distributor cap (1).

(22) Fill the oiler (31) with about 40 drops of oil.

e. Installation and Adjustment. Refer to TM 10-3930-633-12 for procedures on installing the distributor, adjusting and aligning contact points, and adjusting ignition timing.

CHAPTER 4

REPAIR OF FUEL SYSTEM

4-1. General

a. The fuel system consists of the fuel tank (17 gallon capacity), mounted to the right side of the frame, a mechanical, diaphragm-type pump driven off the engine and protected by a fuel filter with a disposable element cartridge, the single-barrel down-draft carburetor, dry-type air cleaner, velocity governor, and the necessary lines and fittings to complete the system. Refer to figure 4-1 for details of the fuel system.

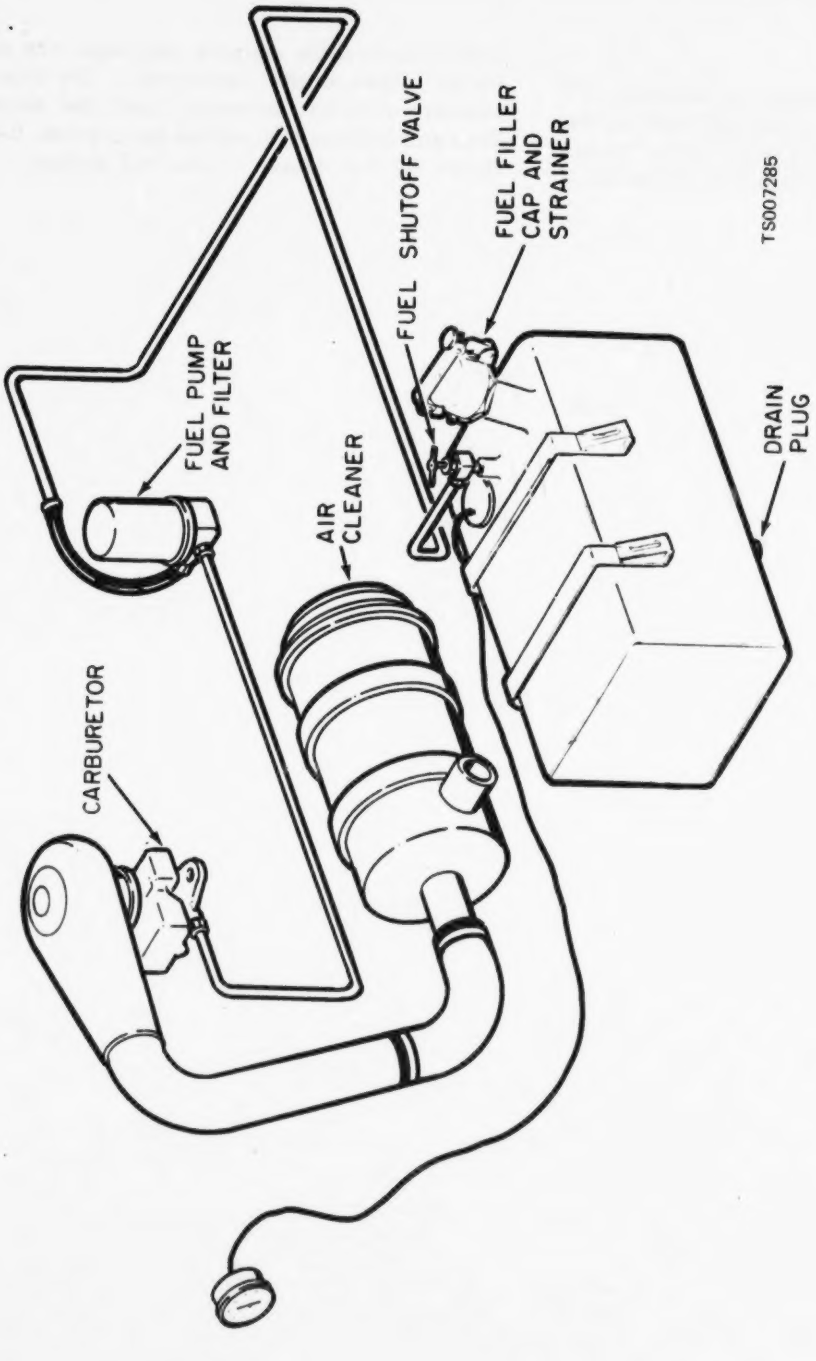

CARBURETOR
AIR CLEANER
FUEL PUMP AND FILTER
FUEL SHUTOFF VALVE
FUEL FILLER CAP AND STRAINER
DRAIN PLUG
TS007285

Figure 4-1. Fuel System.

b. A variable resistance type of float and sender unit is mounted in the fuel tank and connected to a fuel gage on the instrument panel. The fuel filler cap is a safety type with an integral strainer.

4-2. Fuel Tank Repair

a. Removal. Refer to TM 10-3930-633-12, paragraph 4-47.

b. Repair. A cracked or punctured tank may be repaired by welding. However, certain special precautions must be observed as indicated below.

WARNING

The fuel tank must be thoroughly drained and FLUSHED before any cutting or welding is done on the tank surfaces. Fill the tank completely with hot water to drive out all vapors. Drain water and blow out tank with compressed air or CO_2. After welding, fill tank with water and check for leaks. Drain tank, steam clean and dry thoroughly before reinstallation.

c. Installation. Refer to TM 10-3930-633-12, paragraph 4-47.

4-3. Carburetor Problem Diagnosis

a. Flooding, stumble on acceleration or other performance complaints are in many instances caused by the presence of dirt, water or other foreign matter in the carburetor. To aid in diagnosing the cause of the complaint, the carburetor should be carefully removed from the engine without draining the fuel from the bowl. The contents of the fuel bowl may then be examined for contamination as the carburetor is disassembled.

b. Check the fuel in the bowl for contamination by dirt, water, gum or other foreign matter. A magnet moved through the fuel in the bowl will pick up and identify any iron oxide dust that may have caused intake needle and seat leakage.

c. Inspect gasketed surfaces between body and air horn. Small nicks or burrs should be smoothed down to eliminate air or fuel leakage. Be especially particular when inspecting the top surface of the inner wall of the bowl around the power valve passage. A poor seal at this location may contribute to "cutting-out on turns" complaint.

d. Fill the carburetor bowl with clean fuel before installing on manifold. This will help prevent dirt trapped in the fuel system from being dislodged by the free flow of fuel as the carburetor is primed. The operation of the floats and intake needle and seats may be checked under pressure if the fuel pump is used at the bench to fill the carburetor bowl. Operate the throttle several times and visually check the discharge of the pump jets.

4-4. Carburetor Description

a. The carburetor (fig. 4-2) is a concentric unit; the fuel bowl completely surrounds the venturi. It is fitted with a manual choke arrangement.

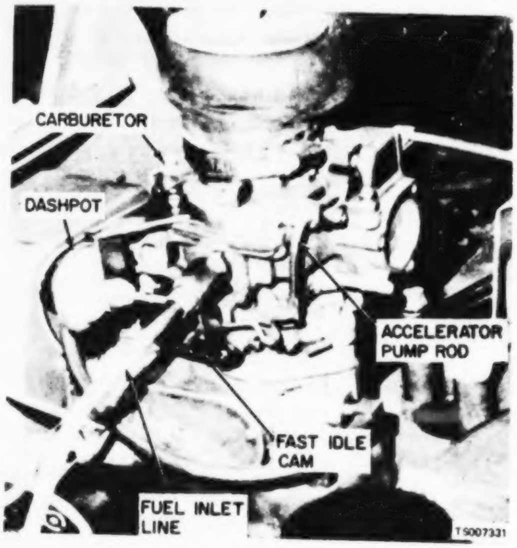


Figure 4-2. Carburetor Installed.

b. Principal subassemblies include the bowl cover, main body, and throttle body. A thick gasket between the throttle body and main body retards heat transfer to the fuel to resist percolation.

c. In addition to the usual circuits, this unit incorporates a spark valve. This is a diaphragm operated, spring loaded valve in the main body connected to the throttle bore port. When the spark valve closes off the port, spark advance vacuum is decreased, retarding the ignition timing.

4-5. Carburetor Repair

a. Removal. Refer to TM 10-3930-633-12 and remove the carburetor assembly from the engine.

b. Disassembly. Refer to figure 4-3 for parts identification and proceed as follows:

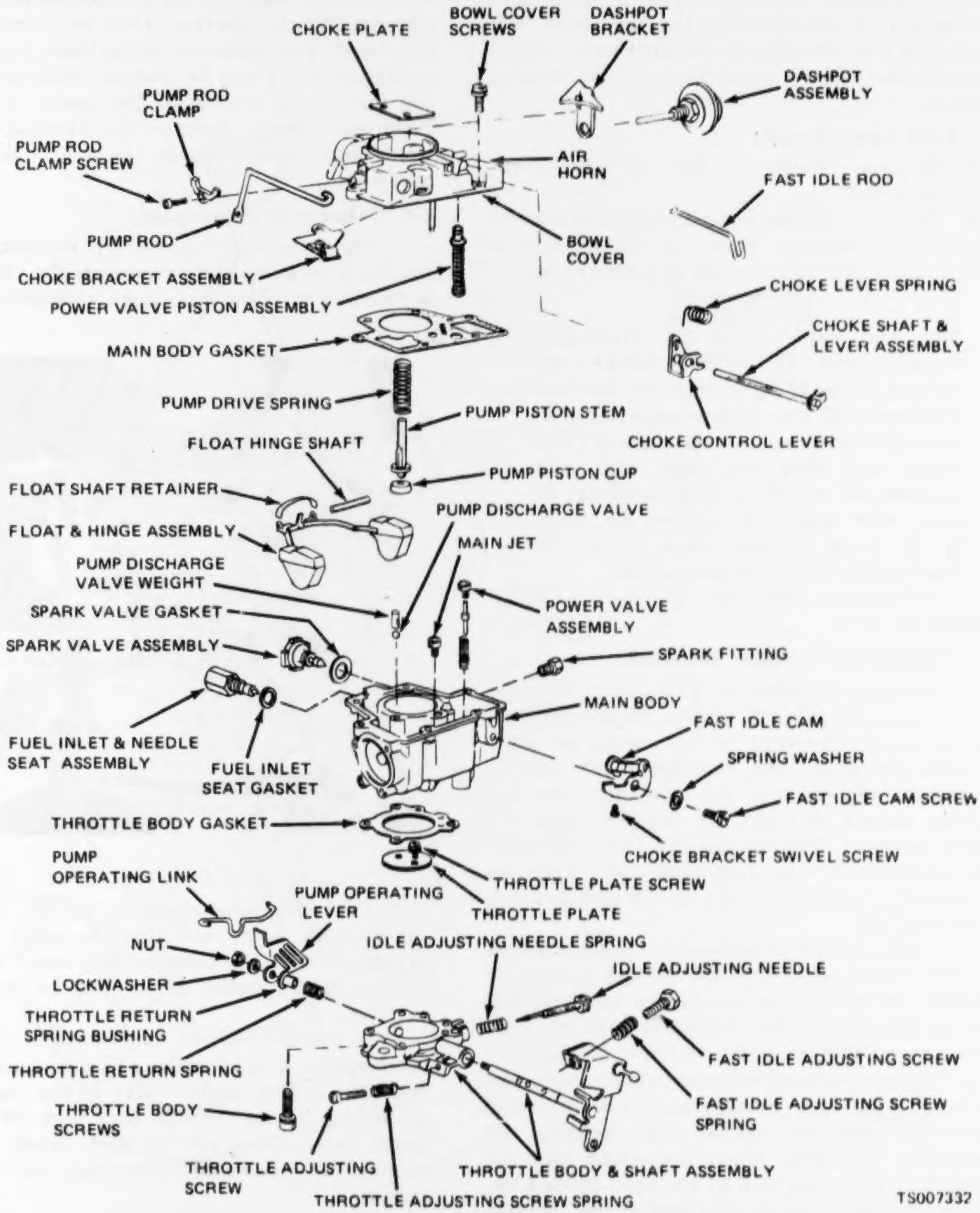

CHOKE PLATE
BOWL COVER SCREWS
DASHPOT BRACKET
DASHPOT ASSEMBLY
PUMP ROD CLAMP
PUMP ROD CLAMP SCREW
AIR HORN
FAST IDLE ROD
PUMP ROD
BOWL COVER
CHOKE BRACKET ASSEMBLY
CHOKE LEVER SPRING
POWER VALVE PISTON ASSEMBLY
CHOKE SHAFT & LEVER ASSEMBLY
MAIN BODY GASKET
PUMP DRIVE SPRING
PUMP PISTON STEM
FLOAT HINGE SHAFT
CHOKE CONTROL LEVER
PUMP PISTON CUP
FLOAT SHAFT RETAINER
PUMP DISCHARGE VALVE
FLOAT & HINGE ASSEMBLY
MAIN JET
PUMP DISCHARGE VALVE WEIGHT
POWER VALVE ASSEMBLY
SPARK VALVE GASKET
SPARK VALVE ASSEMBLY
SPARK FITTING
MAIN BODY
FUEL INLET & NEEDLE SEAT ASSEMBLY
FUEL INLET SEAT GASKET
FAST IDLE CAM
SPRING WASHER
FAST IDLE CAM SCREW
THROTTLE BODY GASKET
CHOKE BRACKET SWIVEL SCREW
PUMP OPERATING LINK
THROTTLE PLATE SCREW
PUMP OPERATING LEVER
THROTTLE PLATE
IDLE ADJUSTING NEEDLE SPRING
NUT
IDLE ADJUSTING NEEDLE
LOCKWASHER
THROTTLE RETURN SPRING BUSHING
FAST IDLE ADJUSTING SCREW
THROTTLE RETURN SPRING
FAST IDLE ADJUSTING SCREW SPRING
THROTTLE BODY SCREWS
THROTTLE ADJUSTING SCREW
THROTTLE BODY & SHAFT ASSEMBLY
THROTTLE ADJUSTING SCREW SPRING
TS007332

Figure 4-3. Carburetor Assembly Exploded View.

(1) Disconnect and remove the fast idle rod, and the pump operating link. Unscrew and remove the dashpot assembly from its bracket.

(2) Remove the bowl cover screws, bowl cover, choke bracket, and dashpot bracket.

(3) Remove the pump rod clamp screw, pump rod and clamp from the bowl cover.

(4) Remove choke plate screws and plate. Pull choke shaft and lever out of bowl cover, and remove choke lever spring and control lever.

(5) Remove throttle body screws and separate main body from throttle body.

(6) Remove throttle plate screws and plate from throttle body bore. Remove nut, lockwasher, pump operating lever, bushing and spring from throttle shaft.

(7) Pull throttle shaft out of throttle body. Remove throttle adjusting screw and spring. Remove idle adjusting needle and spring.

(8) Remove float shaft retainer, hinge shaft, and float assembly from main body. Remove pump drive spring, piston stem, and piston cup.

(9) Remove power valve piston assembly from main body. Remove fast idle cam screw and fast idle cam.

(10) Remove spark valve and gasket, fuel inlet and needle seat, and spark fitting. Remove pump discharge valve weight and discharge valve ball. Remove power valve assembly. Remove main jet only if orifice appears burred, worn, or otherwise damaged. This completes recommended disassembly.

c. Cleaning and Inspection. Dirt, gum, water or carbon contamination on the exterior moving parts of a carburetor are often responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

(1) Thoroughly clean carburetor castings and metal parts in carburetor cleaning solvent.

CAUTION

Accelerator pump plunger and any fiber or rubber parts should never be immersed in carburetor cleaner. Wash pump plunger in cleaning solvent.

(2) Blow out all passages in the castings with compressed air. Dry all parts with compressed air. Make sure all jets and passages are clean. Do not use wire to clean fuel passages or air bleeds.

(3) Check inlet valve needle and seat for wear. If wear is noted, the assembly must be replaced.

(4) Check float hinge pin for wear and check float for damage.

(5) Check throttle and choke shaft bores for wear and out-of-round.

(6) Inspect idle mixture adjustment needles for burrs or grooves; replace if damaged.

(7) Inspect cup of accelerator pump plunger; replace if damaged, worn, or hardened. Inspect pump well in bowl for wear or scoring.

(8) Check filter screens for dirt or lint. Clean, and if they remain clogged, replace.

(9) Check the three main castings carefully for damage such as nicks, burrs, or cracks, around gasket surfaces. Also check the condition and cleanliness of all threaded holes.

d. Reassembly.

NOTE

Always use new gaskets and seals when reassembling carburetor.

(1) Refer to figure 4-3, and reassemble the carburetor assembly as follows:

(2) Install the fuel inlet needle and seat, with gasket, into the main body. Install the spark valve and gasket, and the spark fitting.

(3) Install the fast idle cam, spring washer, and fast idle cam screw.

(4) Install power valve assembly, float and hinge assembly, float hinge shaft, and retainer.

(5) With float installed as above, invert the body and check float position. A straightedge placed across the machined flanges of the bowl should just contact the toes of the float. If necessary, bend the float tang (at the center of the shaft) to obtain this position.

(6) Install idle mixture adjustment needles and springs in throttle body. Tighten finger-tight, then unthread one turn as a preliminary adjustment setting. Install throttle shaft and plate.

CAUTION

Do not force idle mixture adjustment needles against seats, or damage may result.

(7) Invert main body and place new throttle body gasket on bowl. Fasten throttle body to bowl body with screws and lockwashers; tighten securely.

(8) Install pump discharge valve ball and weight into main body. Install pump rod and bracket into bowl cover. Install power valve piston assembly.

(9) Install choke lever, choke shaft, and choke plate in the bowl cover. Assemble the accelerator pump piston to the pump rod inside the bowl cover. Install new main body gasket.

(10) Carefully lower bowl cover down over the main body, and check to see that accelerator pump plunger is guided properly into the well.

(11) Position choke bracket and dashpot bracket, and secure with bowl cover screws. Install remainder of bowl cover screws.

(12) Install fast idle rod and pump operating link, and fast idle screw.

e. Preliminary Adjustments.

(1) With throttle lever in the idle position, the distance from the edge of the vacuum passage casting to the center of the hole in the pump operating rod should be 27/32 inch as shown in figure 4-4. Bend pump rod to obtain proper dimension.

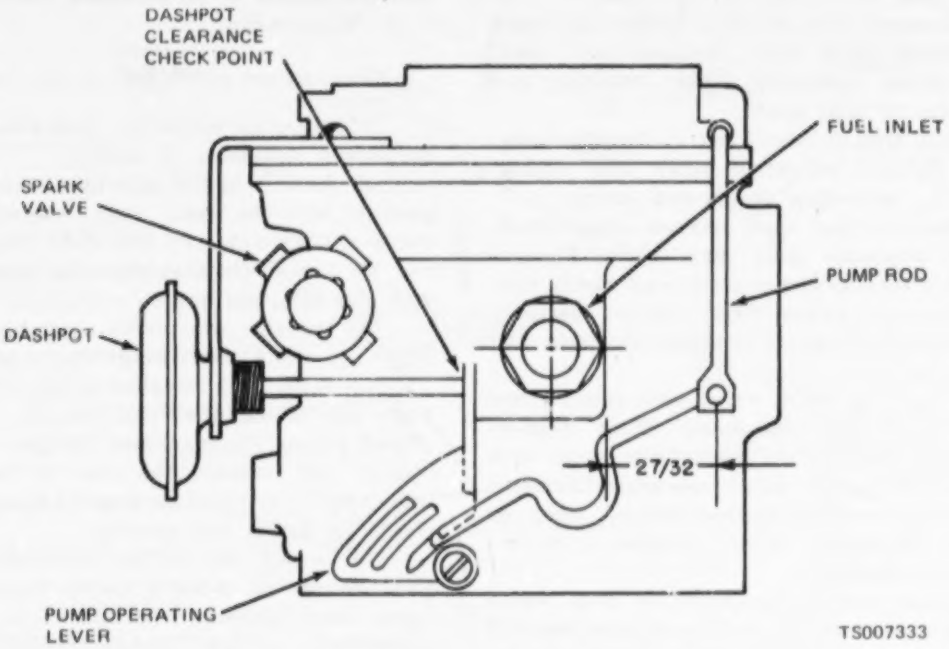

DASHPOT
CLEARANCE
CHECK POINT
FUEL INLET
SPARK
VALVE
PUMP ROD
DASHPOT
27/32
PUMP OPERATING
LEVER
TS007333

Figure 4-4. Pump Adjustment.

(2) With dashpot stem depressed and linkage set at idle speed, 3/32 clearance should exist between end of dashpot stem and tang on pump operating rod. See figure 4-4.

f. Installation. Refer to TM 10-3930-633-12 and install the carburetor. Make final carburetor adjustment after installation according to instructions in TM 10-3930-633-12.

CHAPTER 5

REPAIR OF COOLING SYSTEM

5-1. General

The cooling system is of the pressurized type and utilizes a tube and fin type radiator. The coolant is drawn from the bottom of the radiator by the water pump, which circulates the coolant through the engine block. As the coolant enters the block, it travels through cored passages to cool the entire length of each cylinder wall. Upon reaching the rear of the cylinder block, the coolant is directed upward into the cylinder head where it cools the combustion chambers, valves and valve seats on its return to the front of the engine.

5-2. Cooling System Test

a. General. The cooling system test as outlined in the following paragraph will reveal such problems as blown gaskets, internal or external system leakage, or pressure cap malfunction. The type of pressure tester used should be fitted with a gage, and be adaptable to a hose connection.

b. Procedure.

(1) Shut off the engine. To prevent loss of coolant and to avoid the danger of being burned, place a cloth over the cap and rotate the cap slowly counterclockwise to first stop and allow pressure to escape completely. Then turn cap again slowly counterclockwise to remove.

(2) After the cooling system pressure has been released, remove the radiator cap, wet the rubber sealing surface and reinstall cap tightly on the radiator.

(3) Disconnect the electrical connector from the engine temperature sending unit and remove the temperature sending unit from the manifold. With the radiator cap installed, only a small amount of coolant will be lost when the sending unit is removed.

(4) Install an adapter fitting (3/8 N. P. T. male thread on one end, and a hose connection on the other end to accommodate the tester hose) tightly into the intake manifold or cylinder head in place of the sending unit.

(5) Remove the radiator overflow hose from the retainer clips. Make sure the hose is firmly installed on the radiator overflow tube and is in good condition. Insert the free end of the overflow hose into a container of water.

(6) Attach the pressure pump and gage to the adapter fitting and pressurize the cooling system until bubbles are observed in the water container. Discontinue pumping when bubbles appear.

(7) When the bubbles cease, read the pressure gage. The gage reading is the pressure relief of the cap and should be within specifications. If the pressure reading exceeds the specified limit, replace the radiator cap.

(8) If bubbles continue and the pressure drops below 10 PSI, the radiator cap is not holding pressure. Release pressure and wash cap in clean water to dislodge any foreign matter from the valves. Check the rubber sealing surface of the cap and also the cap sealing surface in the radiator neck. Inspect the cam lock flanges on both sides of the filler neck for maximum cap engagement.

(9) Recheck the cooling system as outlined in steps 6 and 7. If the cap still does not hold pressure, the cap is damaged and must be replaced. Recheck system after a new cap is installed to assure that the system will now hold pressure.

(10) If the bubbles in the water container cease and radiator cap is within pressure specifications, observe gage reading for approximately two minutes. Pressure should not drop during this time.

(11) If pressure drops, check for leaks at the engine to heater core hoses, engine to radiator hoses, by-pass hose, water valve hose (A/C equipped), thermostat housing gasket, etc. Any leaks which are found must be corrected and the system rechecked.

(12) If the system holds pressure, remove the radiator cap to release the pressure, then reinstall the cap.

(13) Remove the adapter from the manifold or cylinder head and reinstall the temperature sending unit. Check coolant level and replenish if necessary with the correct coolant solution.

5-3. Radiator

a. Maintenance. Maintenance of the radiator consists of keeping the exterior of the radiator core clean, the interior free from rust and scale, and the radiator free from leaks. Check the cooling system fluid level and for leaks at each scheduled maintenance interval. The exterior of the radiator core should be cleaned and the radiator inspected for leaks each 1000 operating hours of normal service of the vehicle. Cleaning should be performed by blowing out with air stream or water stream directed from the rear of the radiator. Visual inspection is not sufficient as the accumulation of small particles of foreign material on core surfaces can restrict cooling without closing the core openings.

b. Leakage. Radiator leakage occasionally results from corrosion performation of the metal but most leakage results from mechanical failure of soldered joints when too much strain has been put on the joint. Fractures occur most often at the joint where the radiator inlet and outlet pipes are attached to the tanks. When the seams break, the entire soldered joint is exposed and can corrode, but breakage rather than corrosion is the primary cause of seam leakage. Examine the radiator carefully for leaks before and after cleaning. Cleaning may uncover points of leakage already existing but plugged with rust. White, rusty, or colored leakage stains indicate previous radiator leakage. These spots may not be damp if water only or methyl-alcohol-base antifreeze is in the cooling system since such coolants evaporate readily. An ethylene-glycol-base antifreeze shows up existing leaks as it does not evaporate. The radiator may be tested for leaks by using the procedure outlined in the previous paragraph.

5-4. Radiator Repair

a. Removal and Installation. Refer to TM 10-3930-633-12.

b. Filler Neck. If the seating surface of the radiator cap is corroded or scored, use a commercially available reseating tool to clean up the surface, or use emery cloth or a small grinding wheel. Make certain the locking ears on the lip of the neck are not bent or worn.

c. Overflow Pipe. If the overflow pipe is dented or clogged, the pressure caused by obstruction may cause damage to the radiator or hose connections in the cooling system. To remove clogging material, run a flexible wire through the overflow pipe.

d. Radiator Core. Steam clean the radiator core thoroughly to remove dirt and debris. Direct steam from engine side of core. Straighten any bent fins using needle-nose pliers. Leakage of a minor nature at core and header tank joints may be repaired by soldering; however, a badly corroded, leaking or a punctured core must be replaced.

CHAPTER 6

REPAIR OF ENGINE

Section I. DESCRIPTION

6-1. General

The engine is a six cylinder, in-line, overhead valve design. Engine displacement is 300 cubic inches. The engine is equipped with a 12-volt electrical system, including a coil and distributor type ignition system, starting system, and battery charging system with alternator. The fuel system includes the mechanically operated fuel pump and single throat, down-draft carburetor. Description of these systems is provided under separate chapter headings in this manual.

6-2. Cylinder Head

The cylinder head carries the valves, rocker arms and springs, manifold assemblies, coolant outlet, and thermostat. Valve guides are integral with the head. Refer to Section IV for cylinder head repairs.

6-3. Valves

a. Valve Timing. Valve timing and operation is accomplished by the camshaft, lifters, pushrods, and rocker arms. The camshaft is driven from the crankshaft by a timing chain and sprockets, enclosed in a cover on the front of the engine. The camshaft is supported by four steel-backed babbitt bearings pressed into the block. Camshaft thrust is controlled by a thrust washer located between the camshaft sprocket and the front camshaft journal. An integral eccentric on the camshaft operates the fuel pump.

b. Valve Train. The lifters are of the expanding hydraulic type, where oil under pressure is used to expand the lifter to remove all valve lash from the mechanism. Pushrods are tubular, steel, with oil-cushioned sockets. Intake and exhaust valve assemblies are of the rotating type.

6-4. Cylinder Block

a. The cylinders are numbered from 1 to 6 starting at the front of the engine. The firing order is 1-5-3-6-2-4. The distributor is located on the left side of the engine, toward the front. The distributor is gear driven from the camshaft and, in turn drives the oil pump through an intermediate drive shaft.

b. The crankshaft is supported by four main bearings, with the thrust being controlled by flanges on the number 3 main bearing. The pistons are tin-plated aluminum alloy and have two compression rings and one oil control ring.

6-5. Lubrication System

a. The lubrication system is a positive pressure system and is supplied by a rotor type pump submerged in the crankcase sump. A spring loaded relief valve in the pump limits the maximum pressure of the system. Oil relieved by the valve is directed back to the intake side of the pump.

b. All the oil discharged by the pump passes through a full flow type filter before entering the engine. The filter has an integral bypass valve and mounting gasket. The by-pass valve permits oil to by-pass the filter if it becomes clogged with impurities. thereby maintaining an emergency supply of oil to the engine at all times. An antidrain back diaphragm prevents the reverse flow of oil from the upper engine parts whenever the engine is stopped.

c. From the filter, the oil flows into the main oil gallery, which supplies oil to all the camshaft and main bearings through a drilled passage in each bearing web. The timing gears receive oil through a squirt hole in the block face. Oil slingers prevent leakage by directing oil away from the crankshaft front and rear oil seals.

d. Cylinder walls, pistons, and piston pins are lubricated through a drilled passage in each connecting rod journal of the crankshaft. Drilled passages in the block supply pressurized oil to the hydraulic lifters, pushrods and rocker arms. The oil in the pushrod chamber drains back into the pan through cored openings in the cylinder block.

Section II. ENGINE TEST AND PERFORMANCE ANALYSIS

6-6. General

The performance checks and tests outlined in this section will aid in diagnosing engine condition and determine the extent and location of repairs required to bring the engine up to a serviceable condition.

6-7. Intake Manifold Vacuum Test

a. Test Procedures. A manifold vacuum test aids in determining the condition of an engine and in helping to locate the cause of poor engine performance. To check manifold vacuum:

(1) Operate the engine for a minimum of 30 minutes at 1200 RPM or until the engine is at normal operating temperature.

(2) Connect an accurate, sensitive vacuum gage to the intake manifold vacuum line or on the fitting in the intake manifold. (See figure 6-1.)

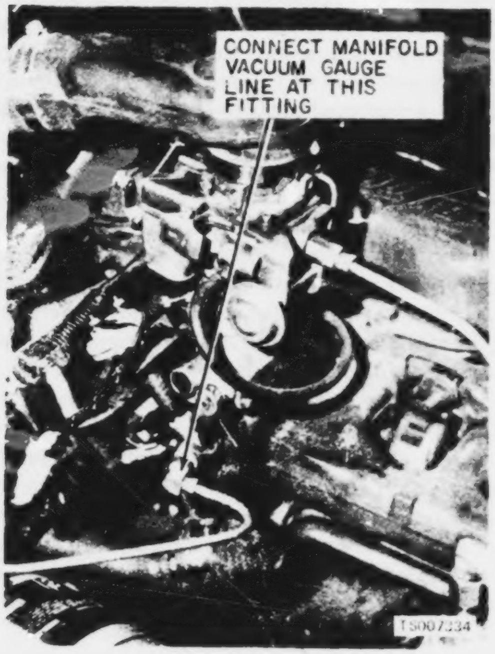


Figure 6-1. Manifold Vacuum Test Connection.

(3) Operate the engine at recommended idle RPM, with the transmission selector lever in neutral.

(4) Check the vacuum reading on the gage, and compare with table 6-1.

b. Test Results. Manifold vacuum is affected by the carburetor adjustment, valve timing, valve lash, ignition timing, condition of the valves, cylinder compression, condition of the positive crankcase ventilation system, and leakage of the intake manifold, carburetor, carburetor spacer or cylinder head gaskets.

c. Readings. Because abnormal gage readings may indicate that more than one of the above factors are at fault, exercise caution in analyzing an abnormal reading. For example, if the vacuum is low, the correction of one item may increase the vacuum enough to indicate that the trouble has been corrected. It is important, therefore, that each cause of an abnormal reading be investigated and further tests conducted, where necessary, in order to arrive at the correct diagnosis of the trouble.

6-8. Compression Test

a. General. A cylinder compression test aids in determing the condition of the valves, rings and head gasket. This test should always be performed at the recommended intervals to help determine if any major engine repairs are necessary.

Table 6-1. Manifold Vacuum Readings.

Gage Reading (inches Hg) (See footnote at end of Table)	Engine Condition
17 or more.	Normal.
Low and steady.	Loss of power in all cylinders caused by late ignition or valve timing, or loss of compression due to leakage around the piston rings.
Very low.	Manifold, carburetor or cylinder head gasket leak.
Needle fluctuates steadily as speed increases.	A partial or complete loss of power in one or more cylinders caused by: a leaking valve, cylinder head or intake manifold gasket leak, a defect in the ignition system or a weak valve spring.
Gradual drop in reading at engine idle.	Excessive back pressure in the exhaust system.
Intermittent fluctuation.	An occasional loss of power possibly caused by a defect in the ignition system or a sticking valve.
Slow fluctuation or drifting of the needle.	Improper idle mixture adjustment, or carburetor spacer or intake manifold gasket leak.

NOTE

Allowance should be made for the effect of altitude on the gage reading. The engine vacuum will decrease with an increase in altitude.

b. Procedure.

(1) Be sure the battery is good. Operate the engine until normal operating temperature is reached. Turn the ignition switch off. Loosen the spark plugs, blow out any dirt in the spark plug wells, then remove the plugs.

(2) Set the carburetor throttle and choke plates in the wide open position.

(3) Install a compression gage in No. 1 cylinder.

(4) Crank the engine (with the ignition switch off) at least five (5) pumping strokes and record the highest reading indicated. Note the approximate number of compression strokes required to obtain the highest reading.

(5) Repeat the check on each cylinder cranking the engine approximately the same number of compression strokes.

c. ***Results.*** The indicated compression pressures are considered normal if the lowest reading cylinder is within 75 percent of the highest. Refer to table 6-2 for pressure limits between cylinders. Variations exceeding 75 percent implies an improperly seated valve or worn or broken piston rings.

Table 6-2. Compression Test Pressure Limits.

Maximum PSI	Minimum PSI
186	140
188	141
190	142
192	144
194	145
196	147
198	148
200	150
202	151
204	153
206	154
208	156
210	157
212	158
214	160

d. Diagnosis. If one, or more, cylinders read low, squirt approximately one (1) tablespoon of engine oil on top of the pistons in the low reading cylinders. Repeat compression pressure check on these cylinders.

(1) If compression improves considerably, the piston rings are at fault.

(2) If compression does not improve, valves are sticking or seating poorly.

(3) If two adjacent cylinders indicate low compression pressures and squirting oil on the pistons does not increase the compression, the cause may be a cylinder head gasket leak between the cylinders. Engine oil and/or coolant in the cylinders could result from this problem.

Section III. ENGINE OVERHAUL

6-9. General

Engine overhaul is the orderly and systematic disassembly and reassembly of the engine, and required replacement of all parts found to be defective, or worn, or otherwise substandard, during the overhaul procedure. While overhaul does not necessarily return the engine to a like new condition, the procedure will result in a completely serviceable engine.

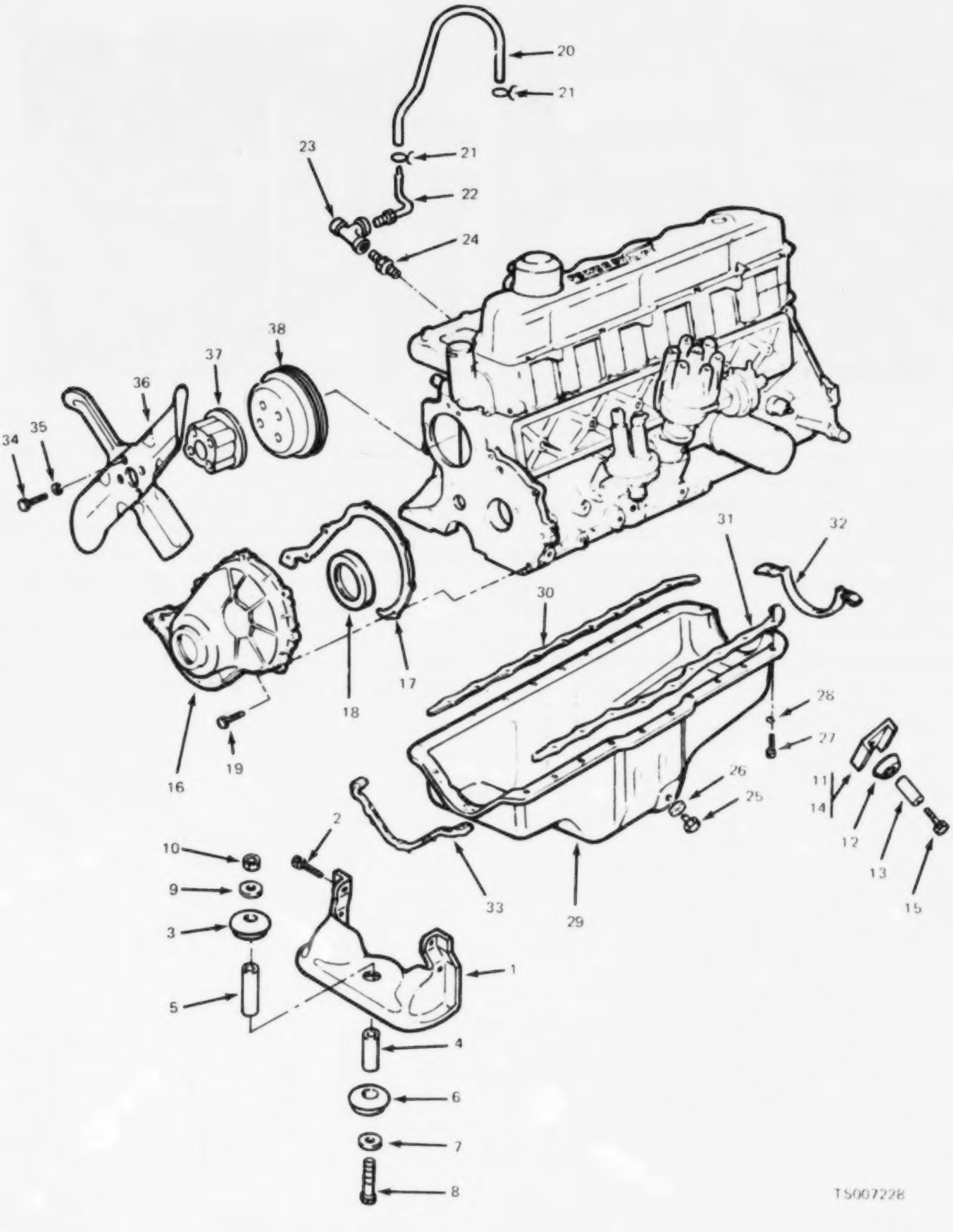
6-10. Disassembly

a. General. Review general maintenance procedures in Chapter 2, Section III, and refer to figures 6-2 through 6-7, while performing disassembly of the engine. Many of the disassembly procedures given here are given in more detail under the individual section headings (Section IV. Cylinder Head and Valves, etc.).

b. Procedure.

(1) Remove the engine front support (1, fig. 6-2).

(2) If available, install the engine on a work stand such as that shown in figure 6-3. A stand of this type will simplify disassembly, as the engine block can be turned to different positions as work proceeds.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1. Support
2. Screw
3. Upper dampener
4. Spacer
5. Spacer
6. Lower dampener
7. Washer
8. Screw
9. Lockwasher
10. Nut
11. Upper dampener
12. Lower dampener
13. Spacer
14. Dampener
15. Screw
16. Cover
17. Gasket
18. Seal
19. Screw
20. Hose
21. Clamp
22. Tube
23. Tee
24. Connector
25. Plug
26. Gasket
27. Screw
28. Washer
29. Oil pan
30. Gasket
31. Gasket
32. Gasket
33. Gasket
34. Screw
35. Lockwasher
36. Fan
37. Hub
38. Pulley

Figure 6-2. Engine Assembly.

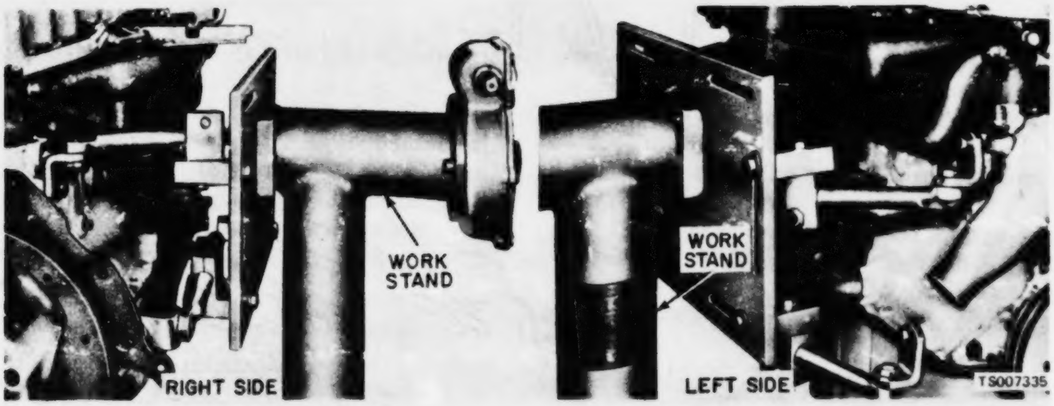


Figure 6-3 Engine on Work Stand.

(3) Disconnect the spark plug wires at the spark plugs. Disconnect the distributor high tension lead at the coil. Remove the distributor cap and spark plug wires as an assembly.

(4) Disconnect the fuel line at the carburetor and fuel pump. Disconnect the vacuum line at the distributor and carburetor. Remove the fuel and vacuum lines.

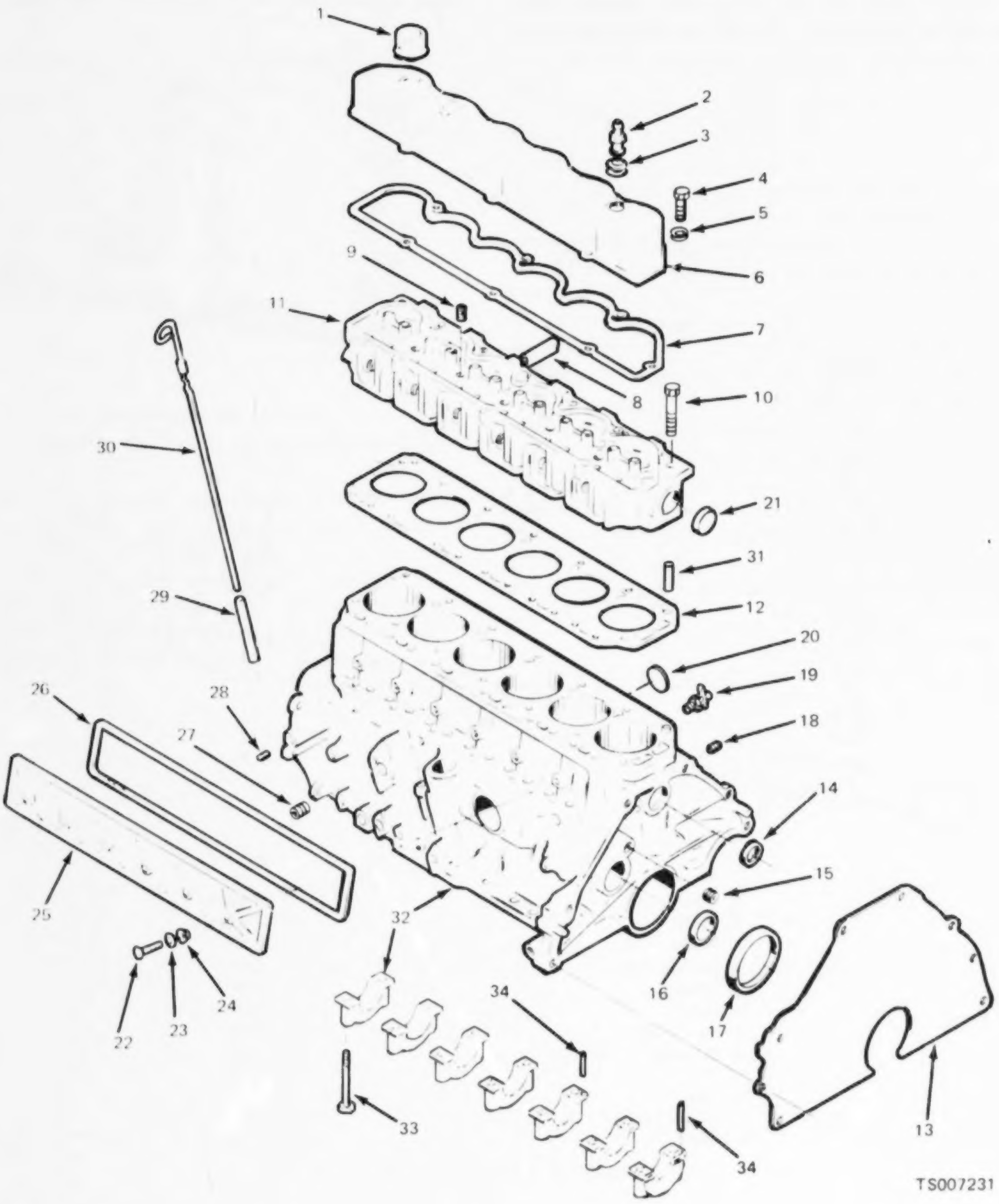
(5) Remove the fuel pump and discard the gasket.

(6) Remove the oil pressure sending unit and the oil level dipstick.

(7) Disconnect the distributor primary wire at the coil, then remove the distributor. Remove the ignition coil and bracket assembly.

(8) Remove the oil filter and oil filter mounting adapter.

(9) Remove the crankcase ventilation regulator valve from the valve rocker arm cover. Remove the rocker arm cover. See figure 6-4.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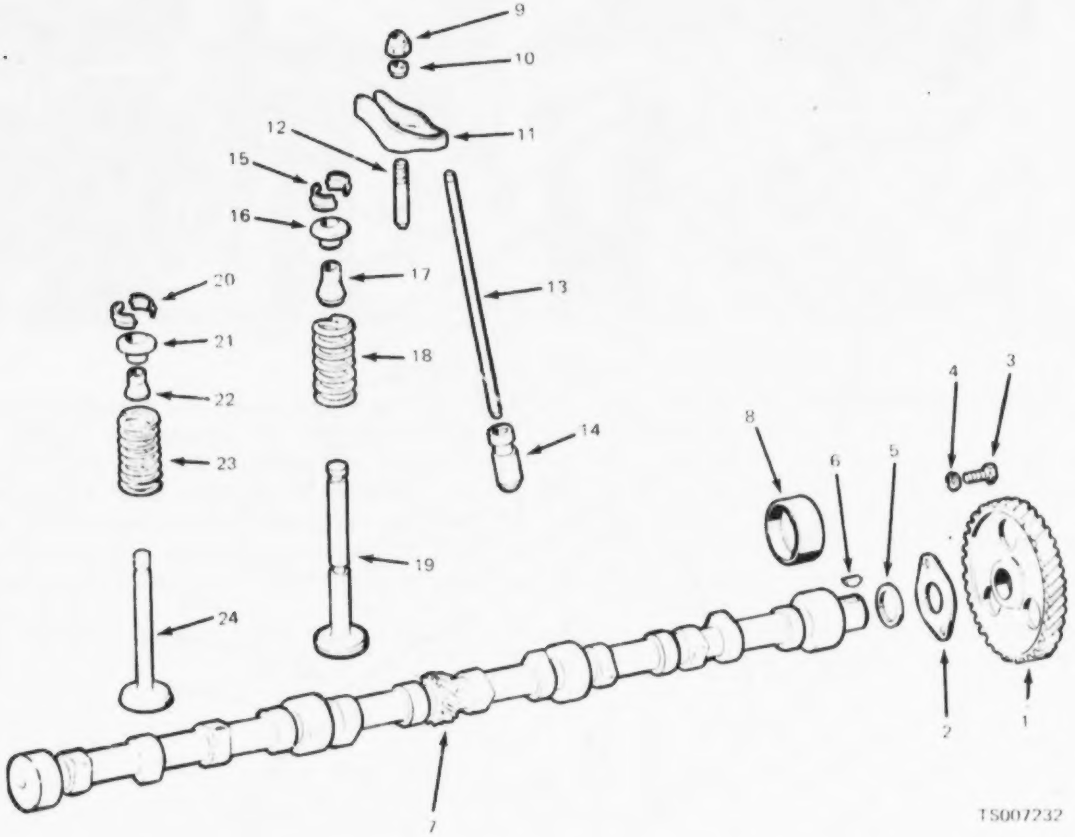
1. Cap
2. Valve
3. Seal
4. Screw
5. Washer
6. Cover
7. Gasket
8. Seal
9. Plug
10. Bolt
11. Cylinder head
12. Gasket
13. Cover
14. Plug
15. Plug
16. Plug
17. Seal
18. Plug
19. Drain cock
20. Plug
21. Plug
22. Screw
23. Washer
24. Grommet
25. Cover
26. Gasket
27. Plug
28. Plug
29. Tube
30. Dipstick
31. Dowel
32. Block and bearing caps
33. Cap bolt
34. Pin

Figure 6-4. Cylinder Block Assembly.

(10) Loosen the rocker arm stud nuts, rotate the rocker arms to one side and remove the pushrods in sequence. Place the pushrods in a rack so they can be installed in the same location from which they were removed. See figure 6-5.



1. Gear
2. Plate
3. Screw
4. Lockwasher
5. Spacer
6. Key
7. Camshaft
8. Bushing
9. Nut
10. Seat
11. Rocker arm
12. Stud
13. Pushrod
14. Tappet
15. Lock
16. Seat
17. Seal
18. Spring
19. Valve
20. Lock
21. Seat
22. Seal
23. Spring
24. Valve

Figure 6-5. Camshaft and Valve Train.

(11) Remove the valve pushrod cover. Remove the valve lifters and place them in order so they may be installed in the same bores from which they were removed. See figure 6-6.

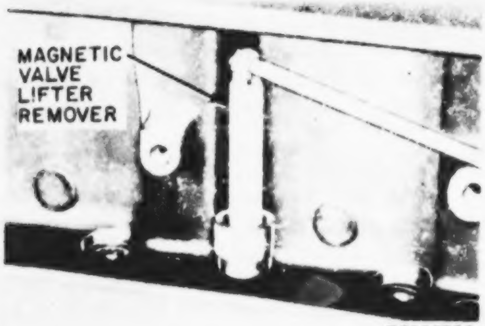


Figure 6-6. Valve Lifter Removal.

(12) Remove the water pump (TM 10-3930-633-12).

(13) Remove the carburetor, intake and exhaust manifold and cylinder head as an assembly (TM 10-3930-633-12).

(14) Remove the crankshaft damper as outlined in paragraph 6-36. Remove the cylinder front cover. Remove the crankshaft front oil seal from the cylinder front cover.

(15) Remove the flywheel and engine rear cover plate.

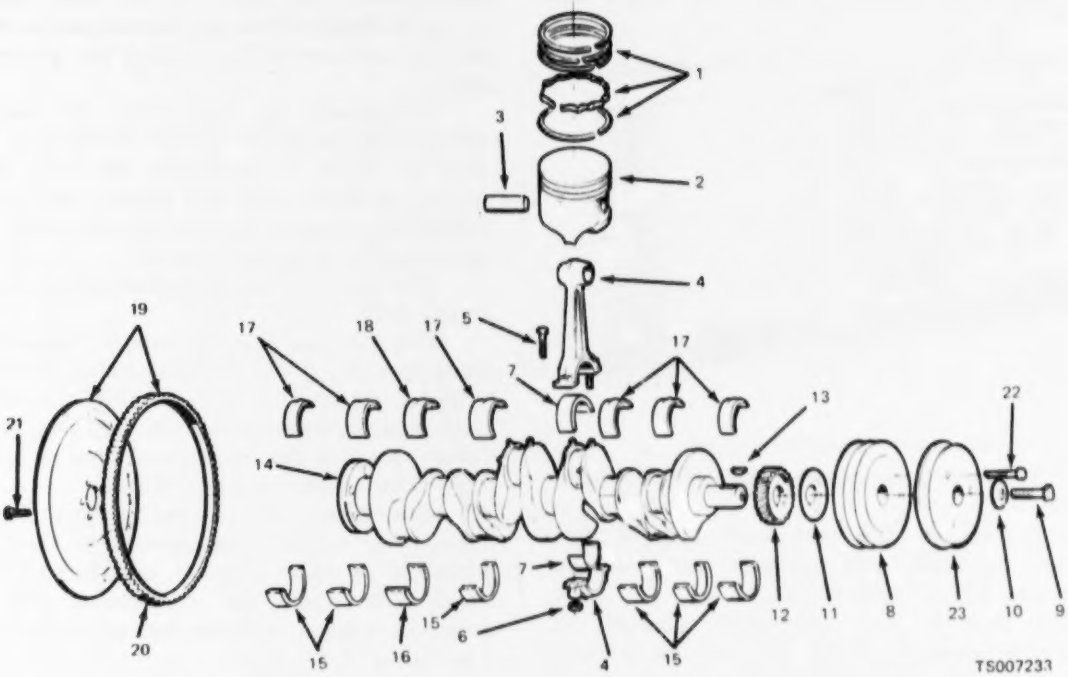
(16) Remove the oil pan and oil pump and pickup tube assembly. Discard the gaskets and seals.

(17) Check the camshaft end play, the timing gear backlash and the timing gear runout (Section VIII). Position the camshaft gear as shown in figure 6-53 and remove the camshaft thrust plate screws. Remove the camshaft, thrust plate and gear as an assembly.

(18) Remove the crankshaft gear as shown in figure 6-37.

(19) Remove any ridge and/or deposits from the upper end of the cylinder bores. Remove the cylinder ridge with a ridge cutter. Follow the instructions furnished by the tool manufacturer. Never cut into the ring travel area in excess of 1/32 inch when removing ridges.

(20) Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod being removed is down. Remove the connecting rod cap. See figure 6-7.



1. Piston ring set
2. Piston and pin assembly
3. Pin
4. Rod
5. Screw
6. Nut
7. Bearing
8. Pulley
9. Screw
10. Washer
11. Slinger
12. Gear
13. Key
14. Crankshaft
15. Bearing half (lower)
16. Thrust bearing (lower)
17. Bearing half (upper)
18. Thrust bearing (upper)
19. Flywheel Assembly
20. Ring Gear
21. Screw
22. Screw
23. Pulley

Figure 6-7. Crankshaft and Pistons.

(21) Push each connecting rod and piston assembly out the top of the cylinder with the handle end of a hammer. Avoid damage to the crankshaft journal or the cylinder wall when removing the piston and rod.

(22) Remove the bearing inserts from the connecting rods and caps. Install the rod caps on the connecting rods from which they were removed.

(23) Remove the main bearing caps. Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Remove the crankshaft rear oil seal. Handle the crankshaft with care to avoid possible fracture or damage to the finished surface.

(24) Remove the main bearing inserts from the cylinder block and main bearing caps.

(25) Remove oil dipstick tube from the cylinder head dowel pins and cylinder block drain plugs.

(26) Disassemble the pistons, piston rings and connecting rods, following the procedures in Section VI.

(27) If the camshaft gear is to be removed from the camshaft, press the camshaft out of the gear in an arbor press. Remove the thrust plate and spacer.

(28) Refer to Section IV for cylinder head and valve work.

6-11. Cleaning, Inspection, Repair and Replacement

Specific procedures and criteria for cleaning, inspection, repair, and parts replacement are given under the individual section headings within this chapter.

6-12. Reassembly

a. General. Certain specific procedures to be followed during reassembly are detailed under the section headings elsewhere in this chapter where the specific component or functional group repair instructions are given. When this is the case, the appropriate section or paragraph is referenced in the reassembly procedure. Refer to table 6-3 for torque values.

b. Procedure

(1) Invert the engine on the work stand. Position new camshaft bearings in the cylinder block, making sure that the oil holes in the bearing are aligned with those in the block. Press them in place. Be sure the camshaft front bearing is installed the specified distance below the front face of the cylinder block. See table 6-7.

(2) Oil the camshaft bearing journals and apply Lubriplate or equivalent to all the lobes. Then carefully slide the camshaft through the bearings.

(3) If the camshaft gear was removed, install the spacer, thrust plate and gear, using a tool similar to that shown in figure 6-55.

(4) Install the thrust plate screws and torque to specifications.

(5) If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean.

(6) Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided.

Table 6-3. Engine Fasteners Torque Values

Item	(Ft lb) Torque
Cylinder Head Bolts Step 1	50-55
Cylinder Head Bolts Step 2	60-65
Cylinder Head Bolts Step 3 (see footnote at end of table)	70-75
Main Bearing Cap Bolts	60-70
Exhaust Manifold to Cylinder Head	23-28
Intake to Exhaust Manifold	28-33
Oil Pump to Cylinder Block	12-15
Oil Pump Cover Plate	9-15
Oil Filter Center Bolt	20-25
Flywheel to Crankshaft	75-85
Damper or Pulley to Crankshaft	130-150
Water Pump to Cylinder Block or Front Cover	15-20
Oil Pick-Up Tube to Oil Pump	12-15
Valve Rocker Arm Cover	4-7
Cylinder Front Cover	12-18
Oil Pan to Cylinder Block	10-12
Oil Pan Drain Plug	15-25
Intake Manifold to Cylinder Head	23-28
Exhaust Manifold to Muffler Inlet Pipe	25-30
Valve Rocker Arm Stud Adjusting Nut Removal Torque (Break-away) counterclockwise	4.5-15
Oil Filter Adapter to Cylinder Block	38-42
Valve Pushrod Chamber Cover (in./lb)	15-20
Fuel Pump to Cylinder Block or Cylinder Front Cover	12-15
Connecting Rod Nuts	40-45
Camshaft Thrust Plate to Block	19-21

NOTE

Repeat after normal engine operating temperatures are reached.

NOTE

Oil threads with lightweight oil unless threads require special sealer.

(7) Install the lower main bearing inserts in the bearing caps.

(8) Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

(9) Check the clearance of each main bearing following the procedure given in paragraph 6-33.

(10) After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

(11) Install the thrust bearing cap and check

the crankshaft end play by following procedures in paragraph 6-34.

(12) Check the camshaft end play, camshaft gear backlash following the procedures in paragraph 6-38. If the end play exceeds specifications, replace the thrust plate. If the gear backlash exceeds specifications, replace the camshaft gear (and crankshaft gear as necessary).

(13) Check the camshaft gear runout with a dial indicator (paragraph 6-38). If the gear runout is excessive, replace the gear.

(14) Check the piston to cylinder bore fit of each piston following the procedure in paragraph 6-27.

(15) Check the end gap of all piston rings (para 6-27). Assemble the pistons, piston rings and connecting rods, following the procedure under Pistons and Connecting Rods Assembly. Check the piston ring side clearance.

(16) Install the piston and connecting rod assemblies and check the clearance of the connecting rod bearings. Refer to paragraph 6-33.

(17) Coat a new crankshaft front oil seal with grease and install it in the cylinder front cover (fig. 6-36).

(18) Coat the gasket surfaces of the cylinder front cover and cylinder block with oil-resistant sealer. Position the gasket on the block and install the cover (fig. 6-36). Torque the bolts to specifications.

(19) Lubricate the damper end of the crankshaft with a white lead and oil mixture. Apply Lubriplate or equivalent to the seal surface of the front oil seal. Apply Lubriplate or equivalent to the seal surface of the crankshaft damper and install the crankshaft damper (fig. 6-48).

(20) Apply a light film of engine oil on a new crankshaft rear oil seal. Apply Lubriplate or equivalent to the seal contact surface of the crankshaft and install the seal (fig. 6-39) the specified distance below the face of the cylinder block. Be sure the seal was not damaged during installation.

(21) Position the engine rear cover plate on the rear of the cylinder block and install the flywheel on the crankshaft. Apply oil-resistant sealer to the threads of the flywheel attaching bolts. Install the bolts and torque them to specifications.

(22) Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Use a new gasket and install the inlet tube and screen on the oil pump. Position a new gasket on the oil pump body and install the oil pump and inlet tube assembly. Torque the attaching bolts to specifications.

(23) Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (fig. 6-41). Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.

(24) Install new side gaskets on the oil pan with oil-resistant sealer (fig. 6-42). Position a new cylinder front cover seal on the oil pan and install the oil pan.

(25) Coat both sides of a new water pump gasket with water-resistant sealer and position the gasket on the cylinder block. Coat the threads of the water pump bolts with water-resistant sealer. Install the water pump. Torque the bolts to specifications.

(26) Assemble the valves, springs, rocker arms, coolant outlet elbow, etc., following the procedures in Section IV.

(27) Place a new cylinder head gasket on the block. Carefully position the cylinder head on the block and install the bolts. Torque the bolts in sequence (TM 10-3930-633-12) to specifications. When cylinder head bolts have been tightened, it is not necessary to retorque the bolts after extended operation. However, the bolts may be checked and retorqued, if desired.

(28) Clean the exterior surface of the valve lifters with a clean, lint-free cloth and oil the surface with engine oil. Install the valve lifters (fig. 6-6) in the same sequence that they were removed.

(29) Apply Lubriplate or equivalent to both ends of the pushrods and to the pushrod bores in the cylinder head. Install the pushrods in the same sequence that they were removed. Be sure the pushrods are properly seated in the valve lifters. Engage the rocker arms with the pushrods and tighten the stud nuts sufficiently to hold the pushrods in place.

(30) Adjust the valve clearance as described in TM 10-3930-633-12.

(31) Coat the gasket surface of the pushrod cover with oil-resistant sealer and position a new gasket on the cover. Install the cover and gasket on the cylinder block. Torque the cover bolts in sequence to specifications.

(32) Install the carburetor, governor, spacer, intake and exhaust manifold, following the procedure in TM 10-3930-633-12.

(33) Clean the valve rocker arm cover. Place the new gaskets in the covers making sure that the tabs of the gasket engage the notches provided in the cover. Install the cover on the cylinder head and torque the cover screws in

sequence to specifications. Install the crankcase ventilation regulator valve in the rocker arm cover. Attach the vent hose to the intake manifold inlet tube.

(34) Install the cylinder block drain plugs and oil pressure sending unit. Install the oil level dipstick tube and dipstick.

(35) Install the oil filter mounting adapter. Coat the seal surface of a new oil filter with grease (or engine oil). Install the oil filter until the seal surface contacts the cylinder block, then tighten the filter an additional ½ turn.

(36) Install the ignition coil and bracket.

(37) Position No. 1 cylinder on TDC after the compression stroke. Set the distributor points to No. 1 cylinder firing position and install the distributor. With the distributor ignition points open position (No. 1 cylinder) install the hold-down clamp and screw. Tighten the screw snug, but not tight.

(38) Use a new gasket and install the fuel pump. Torque the bolts to specifications. Install the carburetor fuel inlet line and distributor vacuum line.

(39) Install the distributor cap and spark plug wires. Connect the spark plug wires. Connect the distributor primary and secondary high tension wires to the ignition coil.

(40) Remove the engine from the work stand. Install the engine front support.

Section IV. CYLINDER HEAD AND VALVES

6-13. General

The cylinder head carries the valves, individually-mounted valve rocker arms, manifold assembly, coolant outlet housing and thermostat. Valve guides are cast integrally in the head. The valve arrangement, from front-to-rear, is exhaust-intake for each cylinder.

6-14. Removal and Disassembly

a. *Removal.* Remove the cylinder head assembly as outlined in TM 10-3930-633-12.

b. *Disassembly.*

(1) Refer to TM 10-3930-633-12 and remove the coolant outlet housing and thermostat, and the intake and exhaust manifolds and carburetor as an assembly.

(2) Remove the spark plugs.

(3) Remove the deposits from the combustion chambers and valve heads with a scraper and a wire brush before removing the valves. Be careful not to scratch the cylinder head gasket surface.

(4) Compress the valve springs (fig. 6-8), then remove the valve spring retainer locks and release the spring.

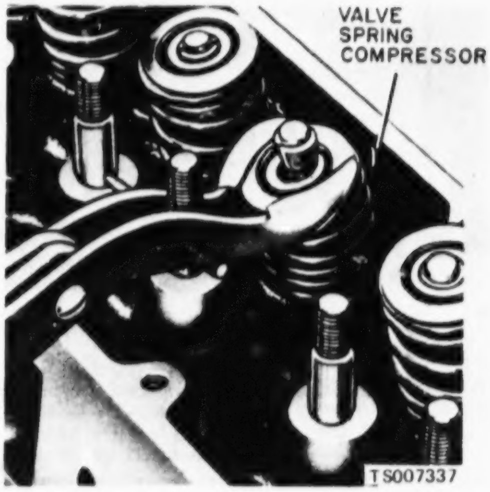


Figure 6-8. Compressing Valve Spring.

(5) Remove the spring retainer, spring, stem seal and valve (fig. 6-9). Discard the valve stem seals. Identify all valve parts.

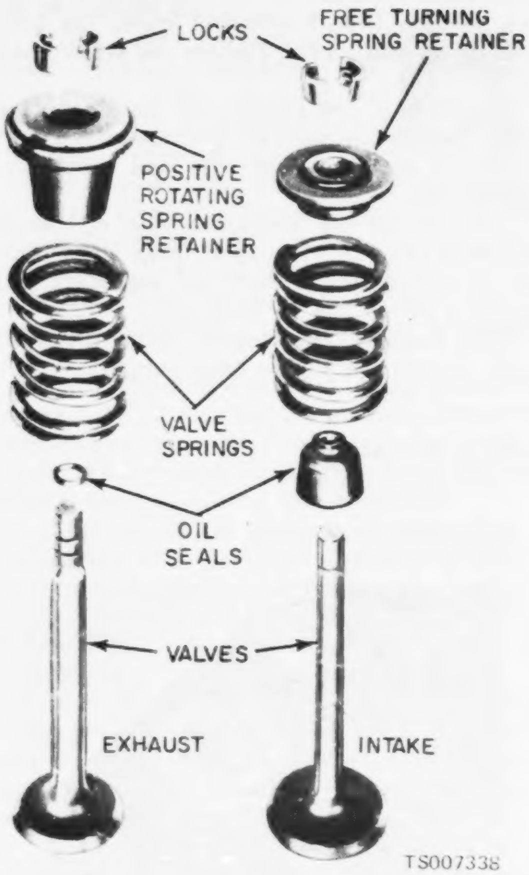

LOCKS
FREE TURNING SPRING RETAINER
POSITIVE ROTATING SPRING RETAINER
VALVE SPRINGS
OIL SEALS
VALVES
EXHAUST
INTAKE
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Figure 6-9. Valve Parts.

6-15. Cylinder Head Cleaning and Inspection

a. Cleaning.

(1) With the valves installed to protect the valve seats, remove deposits from the combustion chambers and valve heads with a scraper and a wire brush.

CAUTION

Be careful not to damage the cylinder head gasket surface.

(2) After valves are removed, clean the valve guide bores with a valve guide cleaning tool. Using cleaning solvent to remove dirt, grease and other deposits. clean all bolt holes.

(3) Remove all deposits from the valves with a fine wire brush or buffing wheel.

b. Inspection.

(1) Inspect the cylinder heads for cracks or excessively burned areas in the exhaust outlet ports.

(2) Check the cylinder head for cracks and inspect the gasket surface for burrs and nicks. Replace the head if it is cracked.

(3) When a cylinder head has been removed due to gasket leakage, check the cylinder head gasket surface for flatness, using a straightedge laid across the surface. A feeler gage can be used under the straightedge to determine warpage. The cylinder head must measure flat within 0.006 inches in any 6 inches of length, or within 0.007 inches overall. The cylinder head may be planed and ground up to 0.010 inch to correct a warped surface.

(4) Check valve seat runout, using a runout gage as shown in figure 6-10. Valve seat runout must not exceed 0.0015 inch. If the reading exceeds this figure, both valve and seat must be refaced.

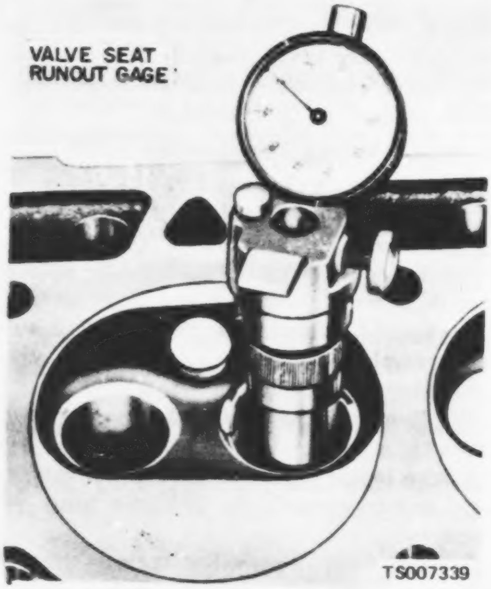


Figure 6-10. Checking Valve Seat Runout.

(5) Check valve seat width, as shown in figure 6-11. Intake valve seats must measure between 0.060 and 0.080 inch, while exhaust valve seats should measure 0.070 to 0.090 inches. Valve seats must be refaced if seat width is not within specifications.

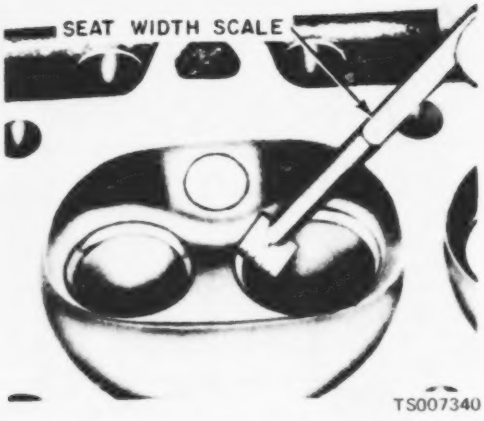


Figure 6-11. Checking Valve Seat Width.

(6) Check the breakaway torque of all rocker arm studs. 4.5 to 15 ft/lbs should be required (counterclockwise) to break the stud away. If breakaway torque is less than this, replace the stud with an oversize stud.

6-16. Cylinder Head Repair

a. Rocker Arm Stud Replacement. Rocker arm studs that are broken or have damaged threads may be replaced with standard studs. Loose studs may be replaced with 0.006, 0.010, or 0.015 inch oversize studs, which are available for service (TM 10-3930-633-34P). Oversize studs may be identified by measuring the stud diameter at a point 1-1/8 inches from the pilot end of the stud. The stud diameters are:

0.006 oversize	0.3774-0.3781
0.010 oversize	0.3814-0.3821
0.015 oversize	0.3864-0.3871

b. Replacement Procedure.

(1) If the rocker arm stud was broken off flush with the stud boss, use an easy-out to remove the broken stud following the instructions of the tool manufacturer.

(2) When going from a standard size rocker arm stud to an 0.010 or 0.015 inch oversize stud, always use the 0.006 inch oversize reamer before finish reaming with the 0.010 or 0.015 inch oversize reamer.

(3) If a loose rocker arm stud is being replaced, ream the stud bore using the proper reamer (or reamers in sequence) for the selected oversize stud (fig. 6-12). Make sure the metal particles do not enter the valve area.

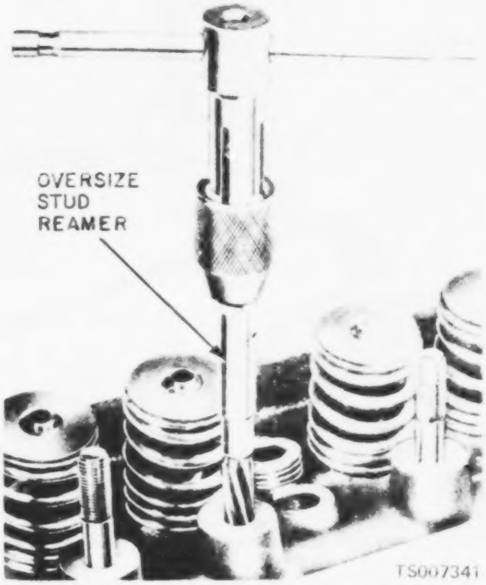


Figure 6-12. Reaming Rocker Arm Stud Bore.

(4) Install new studs with a stud driver tool as shown in figure 6-13. Exercise care to set new stud at same height as adjacent studs not being replaced.

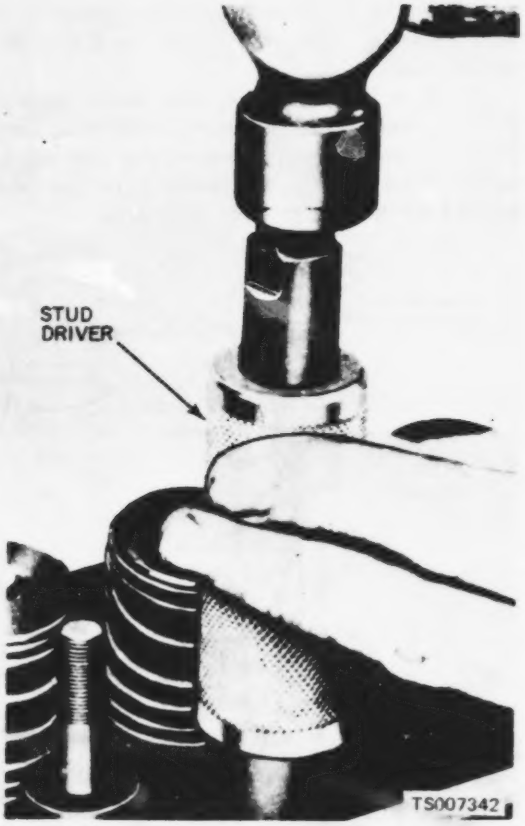


Figure 6-13. Installing New Rocker Arm Studs.

(5) Align the stud and installer with the stud bore, then tap the sliding driver until it bottoms. When the installer contacts the stud boss, the stud is installed to its correct height.

b. Reaming Valve Guides. If it becomes necessary to ream a valve guide (fig. 6-14) to install a valve with an oversize stem, a reaming kit is available which contains the following reamer and pilot combinations: an 0.003 inch OS reamer with a standard diameter pilot, an 0.015 inch OS reamer with an 0.003 inch OS pilot, and an 0.030 inch reamer with an 0.015 inch OS pilot.

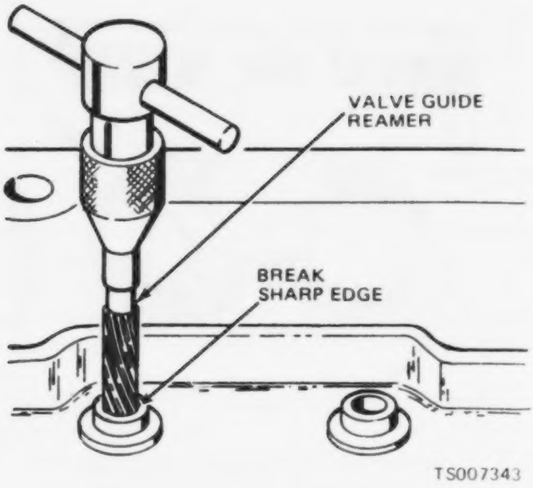


Figure 6-14. Reaming Valve Guides.

(1) When reaming guides for oversize valves, use the smallest reamer first, then the finish size reamer.

(2) Use a suitable scraper or deburring tool to break the sharp edge at the top of the valve guide (fig. 6-14).

(3) Always reface seat after reaming valve guides.

c. Refacing Valve Seats. Refacing of the valve seat should be closely coordinated with the refacing of the valve face so that the finished seat and valve face will be concentric and the specified interference fit will be maintained. This is important so that the valve and seat will have a compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

(1) Grind the valve seats to a true 45 degree angle (figure 6-15). Remove only enough stock to clean up pits and grooves or to correct the valve seat runout. After the seat has been refaced, use a seat width scale or a machinist scale to measure the seat width. Narrow the seat, if necessary, to bring it within specifications.

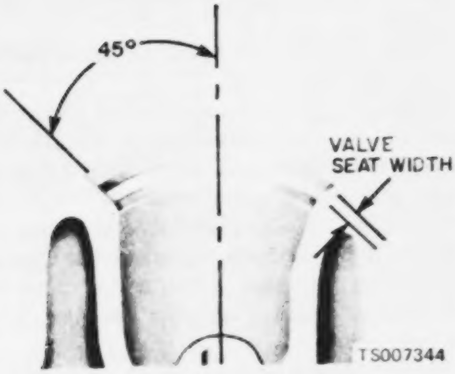


Figure 6-15. Valve Seat Refacing.

(2) If the valve seat width exceeds the maximum limit, remove enough stock from the top edge and/or bottom edge of the seat to reduce the width to specifications.

(3) Use a 60 degree angle grinding wheel to remove stock from the bottom of the seats (raise the seats) and use a 30 degree angle wheel to remove stock from the top of the seats (lower the seats).

(4) The finished valve seat should contact the approximate center of the valve face. It is good practice to determine where the valve seat contacts the face. To do this, coat the seat with Prussian blue and set the valve in place. Rotate the valve with light pressure. If the blue is transferred to the center of the valve face, the contact is satisfactory. If the blue is transferred to the top edge of the valve face, lower the valve seat. If the blue is transferred to the bottom edge of the valve face, raise the valve seat.

6-17. Valve Cleaning and Inspection

a. Cleaning. Remove carbon deposits and sludge or varnish formation from valve stems, seat, and faces with a fine wire brush or buffing wheel.

b. Inspection. Refer to figure 6-16 for all inspection and measurement points, and proceed as follows:

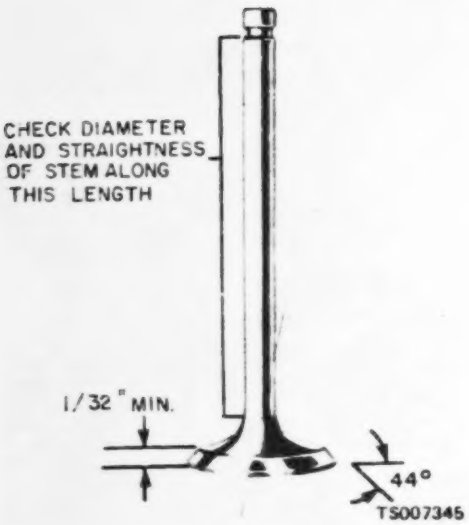


Figure 6-16. Valve Inspection.

(1) Inspect the valve face and the edge of the head for pits, grooves, or scoring.

(2) Check the stem for straightness and for cracks or grooves and scoring around the lock area.

(3) Check the head of the valve for burning or erosion, cupping, warpage or cracks. While minor pits or grooves may be removed during refacing, badly damaged valves should be replaced.

(4) Check the valve face runout. It should not exceed the specified wear limit. If the runout exceeds 0.002 inches, the valve should be replaced or refaced.

(5) Check the valve stem to valve guide clearance of each valve in its respective valve guide with a dial indicator as shown in figure 6-17. Use a flat end indicator point. Clearance should not exceed 0.0010 to 0.0027 for new valves. Maximum wear limit for valves in service is 0.0055.

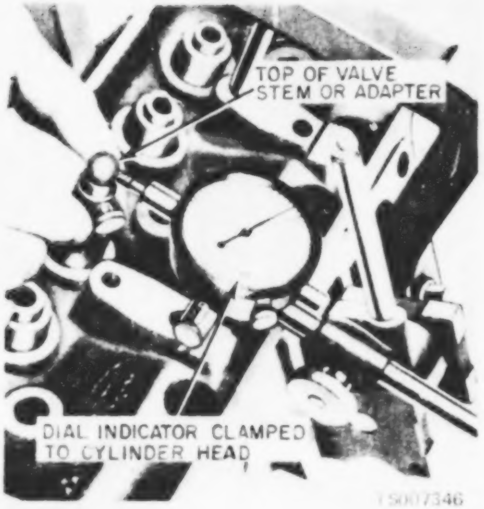

TOP OF VALVE STEM OR ADAPTER
DIAL INDICATOR CLAMPED TO CYLINDER HEAD
TS007346

Figure 6-17. Checking Valve Stem Clearance.

(6) Install the tool on the valve stem until it is fully seated, and tighten the knurled setscrew firmly. Permit the valve to drop away from its seat until the tool contacts the upper surface of the valve guide.

(7) Position the dial indicator with its flat tip against the center portion of the tool's spherical section at approximately 90 degrees to the valve stem axis. Move the tool back and forth in line with the indicator stem. Take a reading on the dail indicator without removing the tool from the valve guide upper surface. Divide the reading by two, the division factor for the tool.

6-18. Refacing Valves

a. Machining. The valve refacing operation should be closely coordinated with the valve seat refacing operations to that the finished angles of the valve face and of the valve seat will be to specifications and provide a compression tight fit. Be sure that the refacer grinding wheels are properly dressed.

(1) If the valve face runout is excessive and/or to remove pits and grooves, reface the valves to a true 44 degree angle. Remove only enough stock to correct the runout or to clean up the pits and grooves. If the edge of the valve head is less than 1/32 inch thick after grinding (fig. 6-16), replace the valve as the valve will run too hot in the engine.

(2) The interference fit of the valve and seat should not be lapped out.

(3) Remove all grooves or score marks from the end of the valve stem, and chamfer it as necessary. Do not remove more than 0.010 inch from the end of the valve stem.

(4) If the valve and/or valve seat has been refaced, it will be necessary to check the clearance between the rocker arm pad and the valve stem with the valve train assembly installed in the engine.

b. Select Fitting Valves. If the valve stem to valve guide clearance exceeds the wear limit, ream the valve guide for the next oversize valve stem. Valves with oversize stem diameters of 0.003, 0.015 and 0.030 inch are available for service. Always reface the valve seat after the valve guide has been reamed.

6-19. Valve Springs Inspection

a. Checking Spring Pressure. Check the valve spring for proper pressure as shown in figure 6-18 at the specified spring lengths. Weak valve springs cause poor performance; therefore, if the pressure of any spring is lower than the wear limit, replace the spring. See table 6-4 for dimensions and readings.

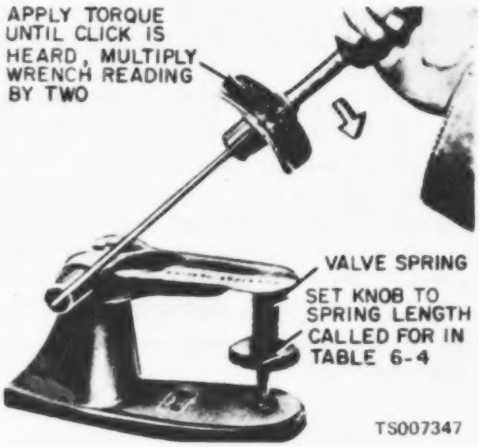

APPLY TORQUE UNTIL CLICK IS HEARD, MULTIPLY WRENCH READING BY TWO
VALVE SPRING
SET KNOB TO SPRING LENGTH CALLED FOR IN TABLE 6-4
TS007347

Figure 6-18. Checking Valve Spring Pressure.

Table 6-4. Valve Spring Specifications

Valve Spring Pressure Lbs. @ Specified Length		Valve Spring Free Length (Approx.)	Valve Spring Assembled Height (Pad to Retainer)	Valve Spring Out of Square (Max.)
Pressure	Wear Limit			
Intake 76-84 @ 1.700 Intake 187-207 @ 1.300	68 @ 1.700 166 @ 1.300	Intake 1.99	Intake 1-11/16-1-23/32	5/64 (0.078)
Exhaust 77.85 - 1.580 Exhaust 182-202 @ 1.180	69 @ 1.300 162 @ 1.180	Exhaust 1.87	Exhaust 1-9/16-1-19/32	

b. Valve Spring Squareness. Check each spring for squareness using a steel square and a surface plate (fig. 6-19). Stand the spring and square on end on the surface plate. Slide the spring up to the square. Rotate the spring slowly and observe the space between the top coil of the spring and square. If the spring is out of square more than 5/64 inch, replace it. Follow the same procedure to check new valve springs before installation.

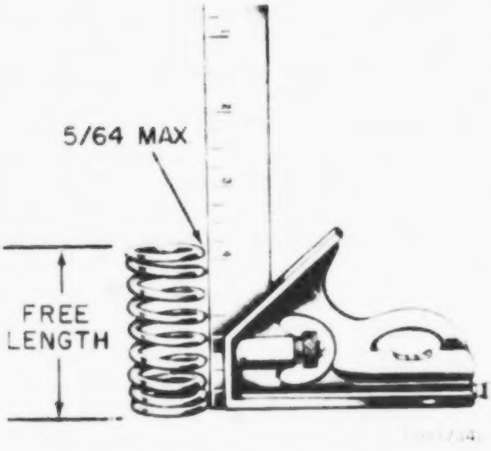


Figure 6-19. Checking Valve Spring Squareness.

6-20. Pushrods and Hydraulic Lifters

a. Pushrod Cleaning.

(1) Clean pushrods by scrubbing with solvent, Federal Specification P-D-680.

(2) Blow out the oil passage through the rod with compressed air.

b. Pushrod Inspection.

(1) Check the ends of the pushrods for nicks, grooves, roughness or excessive wear.

(2) The pushrods can be visually checked for straightness while they are installed in the engine by rotating them with the valve closed. They also can be checked with a dial indicator as shown in figure 6-20. Maximum permissible runout is 0.015 inches.

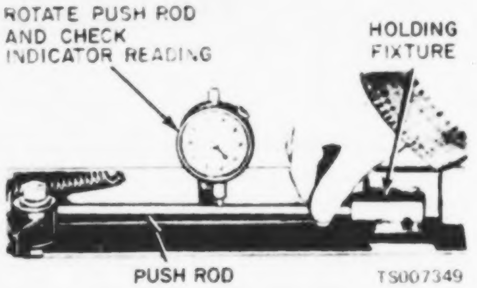


Figure 6-20. Checking Pushrod Straightness.

c. Hydraulic Lifter Cleaning. Clean the lifters thoroughly in a bath of clean solvent, Federal Specification P-D-680. Dry with a clean, lint-free cloth.

NOTE

The valve lifter assemblies should be kept in proper sequence so that they can be installed in their original position. Inspect and test each lifter separately so as not to intermix the internal parts. If any part of the lifter assembly needs replacing, replace the entire assembly.

d. Hydraulic Lifter Inspection.

(1) Inspect the parts and discard the entire lifter assembly if any part shows pitting, scoring, galling or evidence of non-rotation. Replace the entire assembly if the plunger is not free in the body. The plunger should drop to the bottom of the body by its own weight when assembled dry.

(2) Assemble the lifter assembly and check for freeness of operation by pressing down on the pushrod cup. The lifters can also be checked with a hydraulic tester to test the leak-down rate. See figure 6-21.

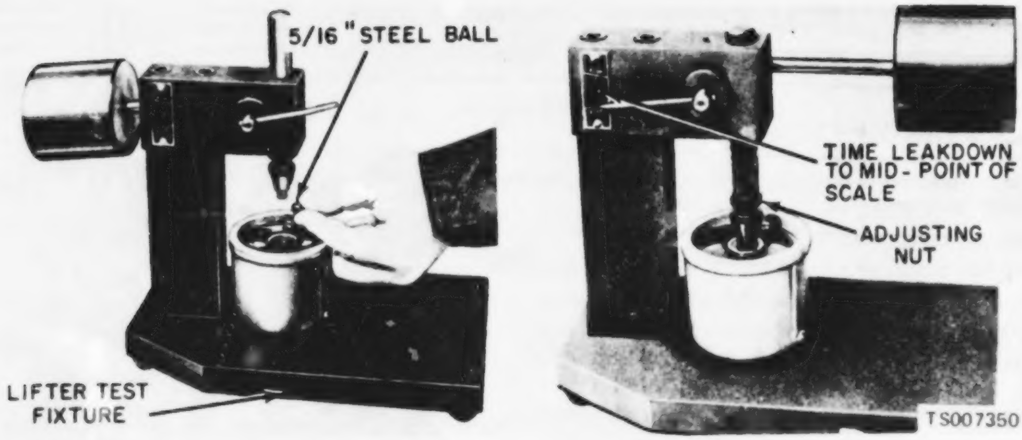


Figure 6-21. Testing Hydraulic Lifter.

(3) Place the valve lifter in the tester, with the plunger facing upward. Pour hydraulic tester fluid into the cup to a level that will cover the valve lifter assembly. The fluid can be purchased from the manufacturer of the tester. Do not use kerosene, for it will not provide an accurate test.

(4) Place a 5/16 inch steel ball in the plunger cup.

(5) Adjust the length of the ram so that the pointer is 1/16 inch below the starting mark when the ram contacts the valve lifter plunger to facilitate timing as the pointer passes the start timing mark. Use the center mark on the pointer scale as the stop timing instead of the original stop timing mark at the top of the scale.

(6) Work the valve lifter plunger up and down until the lifter fills with fluid and all traces of air bubbles have disappeared.

(7) Allow the ram and weight to force the valve lifter plunger downward. Measure the exact time it takes for the pointer to travel from the start timing to the stop timing marks on the tester.

(8) A valve lifter that is satisfactory must have a leak-down rate (time in seconds) within 5 to 50 seconds at 1/16 inch plunger travel.

(9) If the valve lifter is not within specifications, replace it with a new lifter. It is not necessary to test a new lifter before installing it in the engine.

6-21. Valve Installation

a. General. After refacing valve seats and checking all valve train parts as outlined in previous paragraphs, install valves as outlined below. Lubricate valve guides and valve stems with heavy engine oil. Apply Lubriplate or equivalent compound to the tips of the valve stems.

b. Installation.

(1) Install each valve in the valve guide from which it was removed or to which it was fitted.

(2) Oil and install a new intake valve oil seal (fig. 6-9). Do not install the O-ring type seal on the exhaust valves at this time.

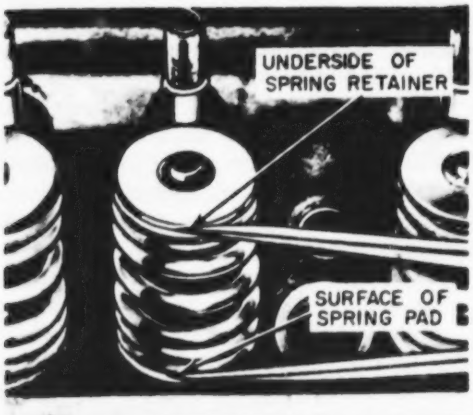
(3) Install the valve spring over the valve. Be sure the closed coil end is placed against the cylinder head.

(4) Position the spring retainer on all valve springs. Make sure that a positive rotating retainer is used on all of the exhaust valves (fig. 6-9).

(5) Compress the spring (fig. 6-8). Apply engine oil to the O-ring type seal, then install it on the exhaust valve. Install the retainer locks.

(6) Measure the assembled height of the valve spring from the surface of the cylinder head spring pad to the underside of the spring retainer with dividers (fig. 6-22).

(7) Check the dividers against a scale. If the assembled height is greater than the specified limit (table 6-4), install the necessary 0.030 inch thick spacer(s) between the cylinder head spring pad and the valve spring to bring the assembled height to the recommended dimension. Do not install spacers unless necessary. Use of spacers in excess of recommendations will result in overstressing the valve springs and overloading the camshaft lobes which could lead to spring breakage and worn camshaft lobes.



TS007351

Figure 6-22. Checking Valve Spring Height.

Section V. CYLINDER BLOCK

6-22. Cylinder Block Cleaning

a. After any cylinder bore repair operation, such as honing or deglazing, clean the bore(s) with soap or detergent and water. Then, thoroughly rinse the bore(s) with clean water to remove the soap or detergent, and wipe the bore(s) dry with a clean, lint-free cloth. Finally, wipe the bore(s) with a clean cloth dipped in engine oil. If these procedures are not followed, rusting of the cylinder bore(s) may occur.

b. If the engine is disassembled, thoroughly clean the block in solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages; then clean out all the passages. Blow out all passages, bolt holes, etc., with compressed air.

c. Make sure the threads in the cylinder head bolt holes are clean. Dirt in the threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove any deposits.

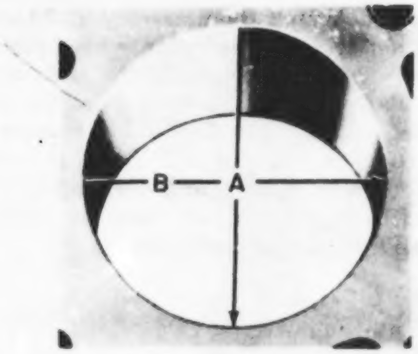
6-23. Cylinder Block Inspection

a. After the block has been thoroughly cleaned, check it for cracks. Minute cracks not visible to the naked eye may be detected by coating the suspected area with a mixture of 25 percent kerosene and 75 percent light engine oil. Wipe the part dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If cracks are present, the coating will become discolored at the cracked area. Replace the block if it is cracked.

b. Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone. Check the cylinder block for flatness of the cylinder head gasket surface following the procedure and specifications recommended for the cylinder head. The cylinder block can be machined to bring the cylinder head gasket surface within the flatness specifications, but not to exceed 0.010 inch stock removal from the original gasket surface.

c. Replace all expansion-type plugs that show evidence of leakage. See paragraph 6-25.

d. Inspect the cylinder walls for scoring, roughness, or other signs of wear. Check the cylinder bore for out-of-round and taper. Measure the bore with an accurate bore gage following the instructions of the manufacturer. Measure the diameter of each cylinder bore at the top, middle and bottom with the gage placed at right angles and parallel to the centerline of the engine (fig. 6-23). Use only the measurements obtained at 90 degrees to the engine centerline when calculating the piston to cylinder bore clearance.



MEASURE A AT RIGHT ANGLE TO ENGINE CENTERLINE.

MEASURE B PARALLEL TO ENGINE CENTERLINE

1. OUT-OF-ROUND=DIFFERENCE BETWEEN A AND B
2. TAPER = DIFFERENCE BETWEEN THE A MEASUREMENT AT TOP OF CYLINDER BORE AND THE A MEASUREMENT AT BOTTOM OF CYLINDER BORE

TS007352

Figure 6-23. Checking Cylinder Bores.

e. Refinish cylinders that are deeply scored and/or when out-of-round and/or taper exceeds the wear limits:

Maximum out-of-round	0.001
Wear limit	0.005
Maximum taper	0.001
Wear limit	0.010
Cylinder bore surface finish RMS	15-35

f. If the cylinder walls have minor surface damage, but the out-of-round and taper are within limits, it may be possible to remove such damage by honing the cylinder walls and installing new service piston rings providing the piston clearance is within specified limits.

6-24. Refinishing Cylinder Walls

a. Machining. Cylinder walls that are severely marred and/or worn beyond the specified limits should be refinished. Before any cylinder is refinished, all main bearing caps must be in place and tightened to the proper torque so that the crankshaft bearing bores will not become distorted from the refinishing operation.

(1) Refinish only the cylinder or cylinders that require it. All pistons are the same weight, both standard and oversize; therefore, various sizes of pistons can be used without upsetting engine balance.

(2) Refinish the cylinder with the most wear first to determine the maximum oversize. If the cylinder will not clean up when refinished for the maximum oversize piston recommended, replace the block.

(3) Refinish the cylinder to within approximately 0.0015 inch of the required oversized diameter. This will allow enough stock for the final step of honing so that the correct surface finish and pattern are obtained.

(4) For the proper use of the refinishing equipment, follow the instructions of the manufacturer. Only experienced personnel should be allowed to perform this work.

b. Honing. Honing is recommended for refinishing cylinder walls only when the walls have minor scuffs or scratches, or for fitting pistons to the specified clearance. The grade of hone to be used is determined by the amount of metal to be removed. Follow the instructions of the hone manufacturer. If coarse stones are used to start the honing operation, leave enough material so that all hone marks can be removed with the finishing hone which is used to obtain the proper piston clearance.

(1) Use a motor-driven, spring pressure-type hone at a speed of 300-500 RPM. Hones of grit sizes 180-220 will normally provide the desired bore surface finish. When honing the cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 MOTOR OIL.

(2) Operate the hone in such a way as to produce a cross-hatch finish on the cylinder bore. The cross-hatch pattern should be at an angle of approximately 30 degrees to the cylinder bore.

(3) After the final operation in either of the two refinishing methods described and prior to checking the piston fit, thoroughly clean and oil the cylinder walls. Mark the pistons to correspond to the cylinders in which they are to be installed.

6-25. Replacing Core Plugs

a. Removal.

(1) To remove larger core plugs, drill a ½-inch diameter hole in the center of the plug and remove with a pilot bearing puller or large drift punch.

(2) On smaller plugs, drill a ¼-inch diameter hole in the center of the plug and pry out with a small pin punch.

(3) Clean and inspect plug bore. Check carefully for any damage that would interfere with the proper sealing of the plug. If the bore is damaged it will be necessary to true the surface by boring for the next specified oversize plug. See TM 10-3930-633-34P.

(4) Oversize (OS) plugs are identified by the OS stamped in the flat located on the cup side of the plug.

b. Installation (Cup Type).

(1) Coat the plug and bore lightly with an oil resistant or water resistant sealer and install as follows:

(2) Cup type core plugs (fig. 6-24) are installed with the flanged edge outward. The maximum diameter of this plug is located at the outer edge of the flange. The flange on cup type plugs flares outward with the largest diameter at the outer (sealing) edge.

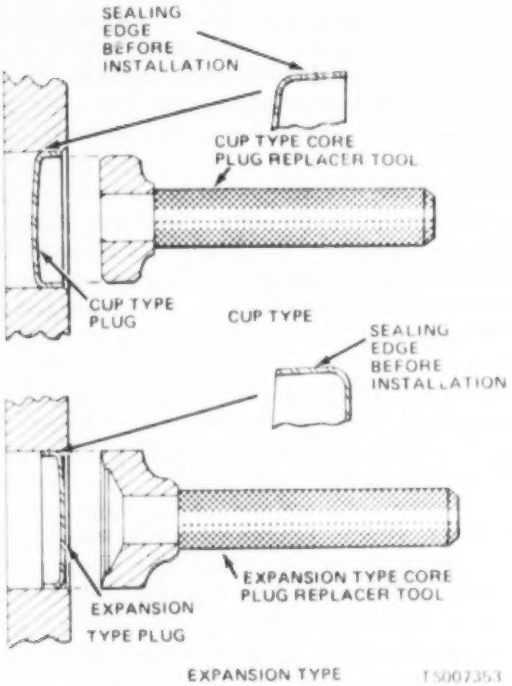

SEALING EDGE BEFORE INSTALLATION
CUP TYPE CORE PLUG REPLACER TOOL
CUP TYPE PLUG
CUP TYPE
SEALING EDGE BEFORE INSTALLATION
EXPANSION TYPE CORE PLUG REPLACER TOOL
EXPANSION TYPE PLUG
EXPANSION TYPE
TS007353

Figure 6-24. Core Plug Installation.

(3) It is imperative to pull the plug into the machined bore by using a properly designed tool. Under no circumstances is the plug to be driven into the bore using a tool that contacts the flange. This method will damage the sealing edge and will result in leakage and/or plug blow out.

(4) The flanged (tailing) edge must be below the chamfered edge of the bore to effectively seal the plugged bore.

(5) If the core plug replacing tool has a depth seating surface, do not seat the tool against a non-machined (casting) surface.

c. Installation (Expansion Type).

(1) Expansion type core plugs are installed with the flanged edge inward. The maximum diameter of this plug is located at the base of the flange with the flange flaring inward.

(2) It is imperative to push or drive the plug into the machined bore using a properly designed tool. Under no circumstances is the plug to be driven using a tool that contacts the crowned portion of the plug. This method will expand the plug prior to installation and may damage the plug and/or plug bore.

(3) When installed the trailing (maximum) diameter must be below the chamfered edge of the bore to effectively seal the plugged bore.

(4) If the core plug replacing tool has a depth seating surface, do not seat the tool against a cast surface.

Section VI. PISTONS, PINS, AND RINGS

6-26. Cleaning and Inspection

a. Cleaning.

(1) Remove deposits from the piston surfaces. Clean gum or varnish from the piston skirt, piston pins and rings with solvent. Do not use a caustic cleaning solution or a wire brush to clean pistons.

(2) Clean the ring groove with a ring groove cleaner (see figure 6-25). Make sure the oil ring slots are clean.

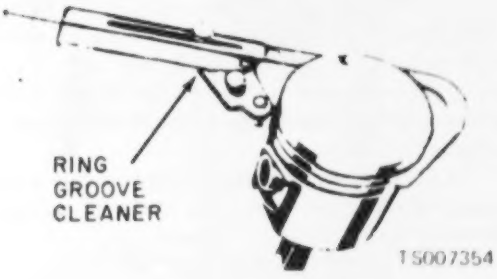


Figure 6-25. Cleaning Ring Grooves.

b. Inspection.

(1) Carefully inspect the pistons for fractures at the ring lands, skirts, and pin bosses, and for scuffed, rough, or cored skirts. If the lower inner portion of the ring grooves have high steps, replace the piston. The step will interfere with ring operation and cause excessive ring side clearance.

(2) Spongy, eroded areas near the edge of the piston top are usually caused by detonation or pre-ignition. A shiny surface on the thrust surface of the piston, offset from the centerline between the piston pin holes, can be caused by a bent connecting rod. Replace pistons that show signs of excessive wear, wavy ring lands or fractures, or damage from detonation or pre-ignition.

(3) Check the piston cylinder bore clearance by measuring the piston and bore diameters. Refer to table 6-5 for the proper clearance. Refer to paragraph 6-23 for the bore measurement procedure. Measure the OD of the piston with micrometers at the centerline of the piston bore and at 90 degrees to the pin bore axis. Check the ring side clearance following the procedure under Fitting Piston Rings in this section.

(4) Replace piston pins showing signs of fracture, etching or wear. Check the piston pin fit in the piston and rod. Refer to table 6-5.

(5) Check the OD of the piston pin and the ID of the pin bore in the piston. Replace any piston pin or piston that is not within specifications (table 6-5).

(6) Replace all rings that are scored, chipped or cracked. Check the end gap and side clearance. It is good practice to always install new rings when overhauling an engine. Rings should not be transferred from one piston to another regardless of mileage.

Table 6-5. Piston, Pin, and Ring Fits

ITEM	INCHES
PISTON	
Diameter (red code)	3.9984-3.9990
Diameter (blue code)	3.9996-4.0002
Diameter (0.003 oversize)	4.0008-4.0014
Piston-to-bore clearance	0.0014-0.0022
Pin bore diameter	0.9753-0.9756
Ring groove width:	
Top	0.0800-0.0810
Bottom	0.0800-0.0810
Oil ring	0.1880-0.1890
PISTON PIN	
Length	3.150-3.170
Diameter (std)	0.9750-0.9753
Diameter (.001)	0.9760-0.9763
Diameter (.002)	0.9770-0.9773
Clearance (in piston)	0.0002-0.0004
Clearance (in rod bushing)	interference
PISTON RINGS	
Width (compression rings)	0.0770-0.0780
Side clearance (top ring)	0.002-0.004
Side clearance (bottom ring)	0.0025-0.0040
Side clearance (oil ring)	snug fit
Ring gap (top ring)	0.010-0.020
Ring gap (bottom ring)	0.010-0.020
Ring gap (oil ring)	0.015-0.055

6-27. Fitting Pistons and Rings to Bore

Pistons are available for service replacement in the standard size as well as in 0.020, 0.030 and 0.040 inch oversizes. All pistons are matched for weight, regardless of size. Standard pistons are coded red or blue, or have "0.003 OS" stamped on the dome. Refer to table 6-5 for dimensions.

a. Fitting Pistons.

(1) Measure the cylinder bore and select the piston to assure the proper clearance. When the bore diameter is in the lower one-third of the specified range, a red piston should be used. When the bore diameter is in the middle one-third a blue piston should be used. When the bore diameter is in the upper one-third, the 0.003 OS piston should be used.

(2) Measure the piston diameter to ensure that the specified clearance is obtained. It may be necessary periodically to use another piston (within the same grade size) that is either slightly larger, or smaller, to achieve the specified clearance.

(3) If none can be fitted, refinish the cylinder to provide the proper clearance for the piston.

(4) When a piston has been fitted, mark it for assembly in the cylinder to which it was fitted.

b. Fitting Rings. If the taper, out-of-round and piston to cylinder bore clearance conditions of the cylinder bore are within specified limits, new piston rings will give satisfactory service. If new rings are to be installed in a used cylinder that has not been refinished, remove the cylinder wall glaze (para 6-24, Refinishing Cylinder Walls). Be sure to clean the cylinder bore thoroughly.

(1) Calculate the size piston to be used by taking a cylinder bore check, or use the properly fitted piston, determined in subparagraph *a*.

(2) Select the proper ring set for the size cylinder bore.

(3) Position the ring in the cylinder bore in which it is going to be used.

(4) Push the ring down into the bore area where normal ring wear is not encountered.

(5) Use the head of a piston to position the ring in the bore so that the ring is square with the cylinder wall. Use caution to avoid damage to the ring or cylinder bore.

(6) Measure the gap between the ends of the ring with a feeler gage (fig. 6-26). If the ring gap is less or greater than the specified limits, try another ring set.

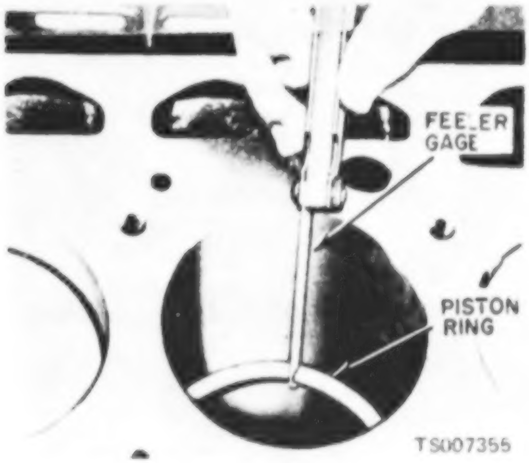


Figure 6-26. Checking Ring Gap.

(7) Check the ring side clearance of the compression rings with a feeler gage inserted between the ring and its lower land (fig. 6-27). The gage should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

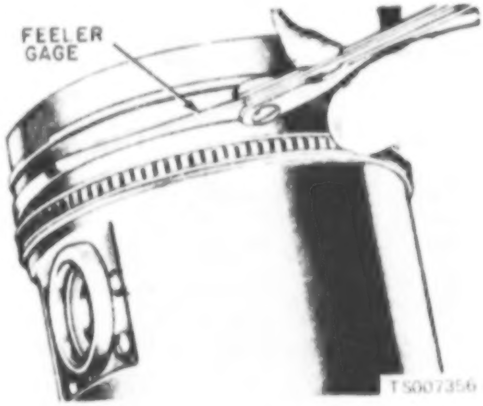


Figure 6-27. Checking Ring Side Clearance.

6-28. Assembly and Installation

a. General. The piston, connecting rod and related parts are shown in figure 6-28. Check the fit of a new piston in the cylinder bore before assembling the piston and piston pin to the connecting rod, following the procedures in subparagraph *b*. The piston pin bore of a connecting rod and the diameter of the piston pin must be within specifications.

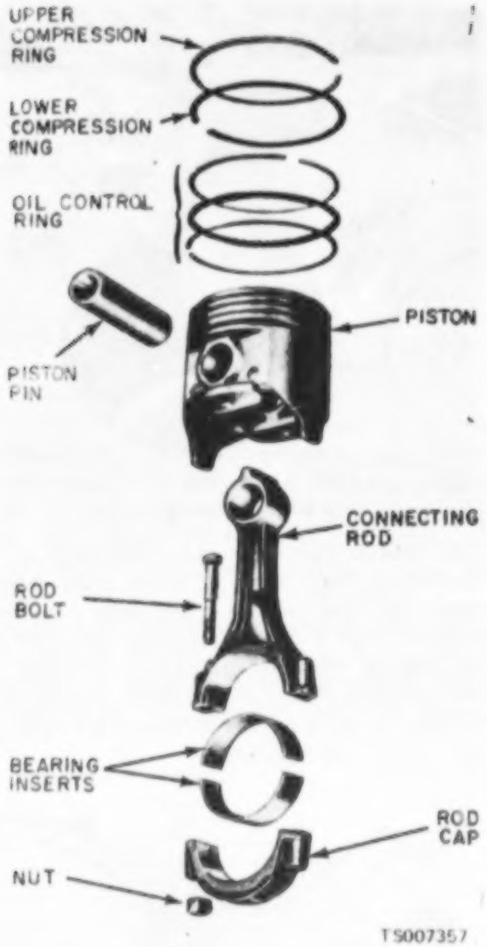

UPPER COMPRESSION RING
LOWER COMPRESSION RING
OIL CONTROL RING
PISTON
PISTON PIN
CONNECTING ROD
ROD BOLT
BEARING INSERTS
ROD CAP
NUT
TS007357

Figure 6-28. Piston and Connecting Rod Assembly.

b. Assembly.

(1) Apply a light coat of engine oil to all parts. Assemble the piston to the connecting rod with the bearing tang side of the connecting rod and the indentation notch in the piston positioned as shown in figure 6-29.

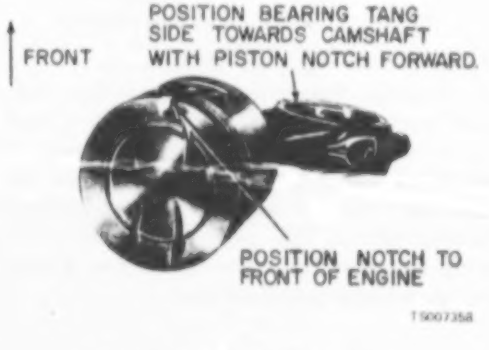

FRONT
POSITION BEARING TANG SIDE TOWARDS CAMSHAFT WITH PISTON NOTCH FORWARD.
POSITION NOTCH TO FRONT OF ENGINE
TS007358

Figure 6-29. Oil Hole Position.

(2) Start the piston pin in the piston and connecting rod. Using an arbor press, press the piston pin through the piston and connecting rod until the pin is centered in the connecting rod (fig. 6-30).

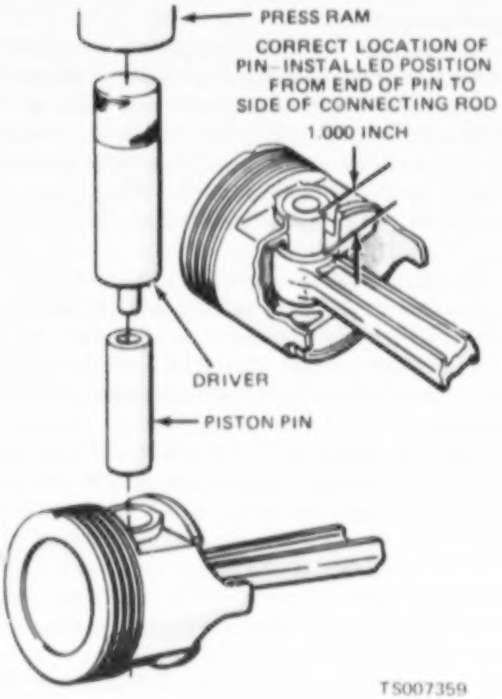

PRESS RAM
CORRECT LOCATION OF PIN—INSTALLED POSITION FROM END OF PIN TO SIDE OF CONNECTING ROD
1.000 INCH
DRIVER
PISTON PIN
TS007359

Figure 6-30. Installing Piston Pin.

(3) Check the end gap of all piston rings (para 6-27). It must be within specifications. Follow the instructions contained on the piston ring package and install the piston rings.

(4) Check the ring side clearance of the compression rings with a feeler gage inserted between the ring and its lower land (fig. 6-27). The gage should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have steps, the piston should be replaced.

(5) Be sure the bearing inserts and the bearing bore in the connecting rod and cap are clean. Foreign material under the inserts will distort the bearing and cause a failure. Install the bearing inserts in the connecting rod and cap with the tangs fitting in the slots provided.

c. Installation.

(1) Clean the oil pump inlet tube screen and the oil pan and block gasket surfaces.

(2) Oil the piston rings, pistons and cylinder walls with light engine oil.

(3) Be sure to install the pistons in the same cylinders from which they were removed or to which they were fitted. The connecting rods and bearing caps are numbered from 1 to 6 beginning at the front of the engine. The number on the connecting rod and bearing cap must be on the same side of rod when installing in the cylinder bore. If a connecting rod is ever transferred from one cylinder block to another or from one cylinder to another, new bearings should be fitted and the connecting rod should be renumbered to correspond with the new cylinder number.

(4) Make sure the ring gaps are properly spaced around the circumference of the piston (figure 6-31). Oil the rings, then install a piston ring compressor on the piston. Make sure that the indentation in the head of piston is toward the front, then push the piston into its bore with the handle end of a hammer until it is slightly below the top of the cylinder (fig. 6-32). Be sure to guide the connecting rods to avoid damaging the crankshaft journals.

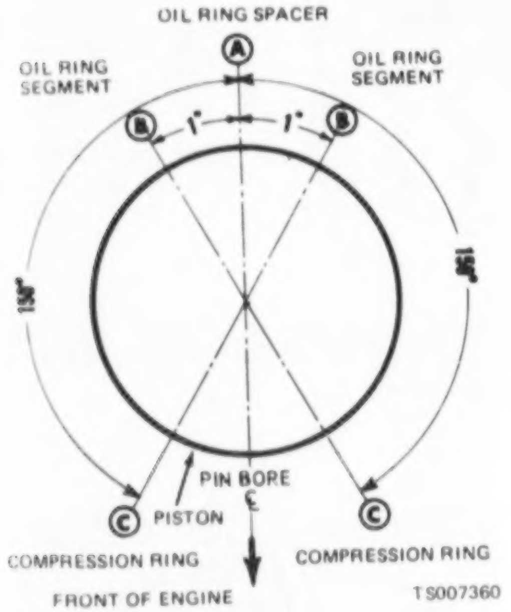

OIL RING SPACER
A
OIL RING SEGMENT
B
1°
1°
B
OIL RING SEGMENT
150°
150°
PIN BORE
℄
PISTON
C
C
COMPRESSION RING
COMPRESSION RING
FRONT OF ENGINE
TS007360

Figure 6-31. Piston Ring Gap Spacing.

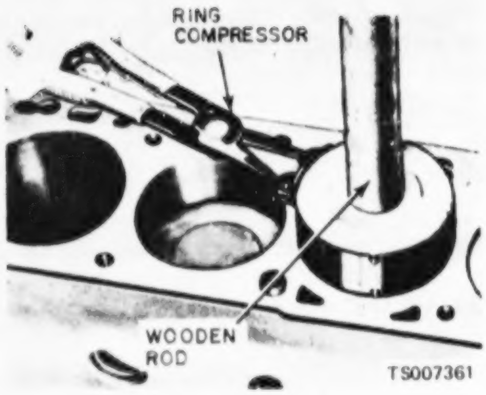

RING COMPRESSOR
WOODEN ROD
TS007361

Figure 6-32. Piston Installation.

(5) Check the clearance of each bearing following the procedure under paragraph 6-33, Connecting Rod Bearing Replacement.

(6) After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings.

(7) Turn the crankshaft throw to the bottom of its stroke, then push the piston all the way down until the connecting rod bearing seats on the crankshaft journal. Install the connecting rod cap. Torque the nuts to specifications.

(8) After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (fig. 6-33). Side clearance should be 0.0060 to 0.0130 inches.

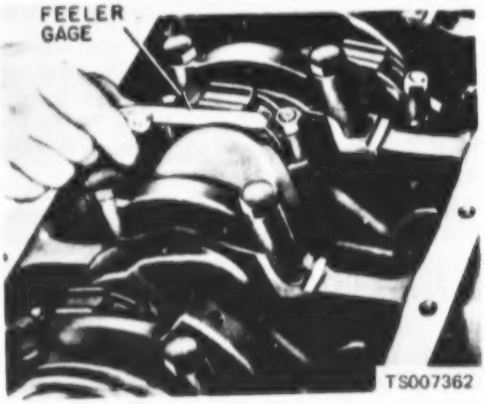

FEELER GAGE
TS007362

Figure 6-33. Checking Rod Side Clearance.

(9) Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install the oil pump and the oil pump inlet tube. Install the oil pan and replated parts.

(10) Refer to Cylinder Head Installation, TM 10-3930-633-12, and install the cylinder head and related parts. Adjust the valve clearance as described in TM 10-3930-633-12.

Section VII. CONNECTING RODS AND CRANKSHAFT

6-29. Crankshaft Removal and Installation

See figure 6-34 for parts identification of crankshaft and related parts.

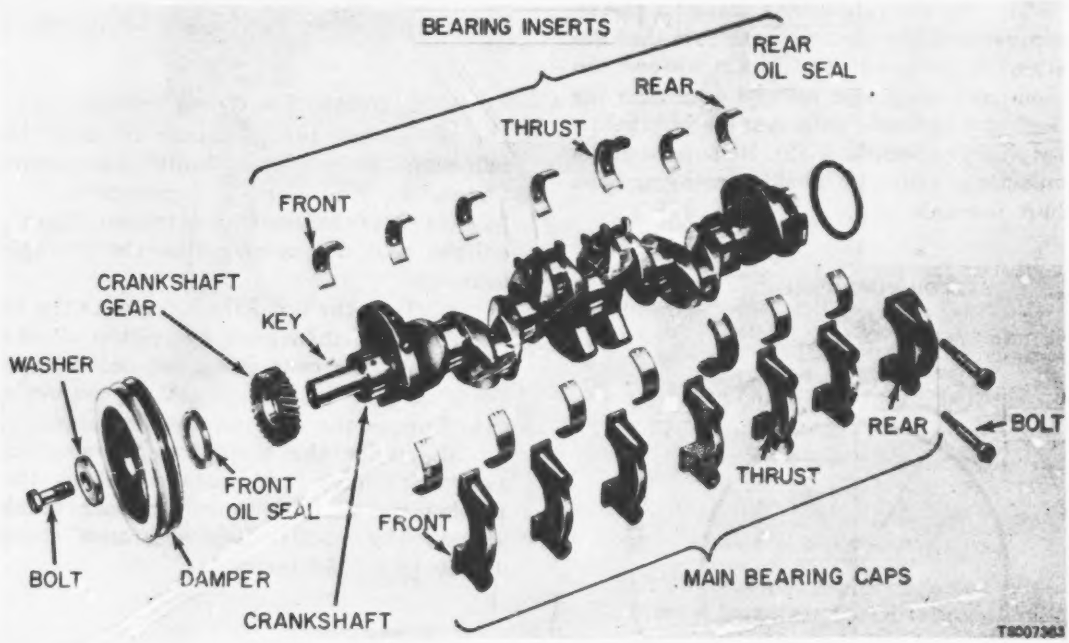

BEARING INSERTS
REAR OIL SEAL
REAR
THRUST
FRONT
CRANKSHAFT GEAR
KEY
WASHER
FRONT OIL SEAL
FRONT
REAR
BOLT
THRUST
BOLT
DAMPER
CRANKSHAFT
MAIN BEARING CAPS
TS007363

Figure 6-34. Crankshaft and Related Parts.

a. Removal.

(1) Install the engine on a work stand. Remove the spark plugs to allow easy rotation of the crankshaft.

(2) Remove the oil level dipstick.

(3) Remove the crankshaft damper attaching bolt and lockwasher. Remove the crankshaft damper (fig. 6-35).

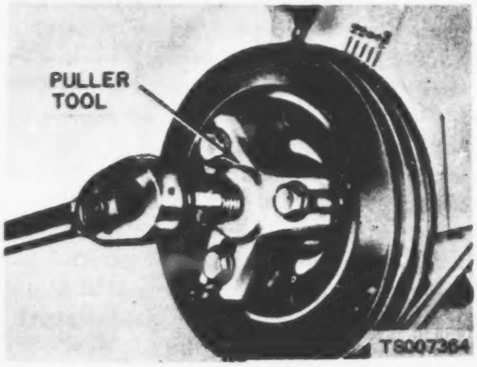

PULLER TOOL
TS007364

Figure 6-35. Removing Crankshaft Damper.

(4) Remove the cylinder front cover and gasket.

(5) Remove the flywheel and engine rear cover plate.

(6) Turn the engine on the work stand so that the bottom of the engine is up. Remove the oil pan, gaskets and seals. Remove the oil pump and inlet tube assembly. Discard the oil pump gasket.

(7) Use an awl to punch two holes in the crankshaft rear oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.

(8) Make sure all bearing caps (main and connecting rod) are marked so that they can be installed in their original locations. Turn the crankshaft until the connecting rod from which the cap is being removed is at the bottom of the stroke. Remove the connecting rod cap and bearings. Push the connecting rod and piston assembly up in the cylinder. Do not turn the crankshaft completely around as the rod bolts may damage the crankpin journals. Repeat this procedure and remove all connecting rod caps.

(9) Align the timing marks (fig. 6-36). Remove the crankshaft gear (fig. 6-37).

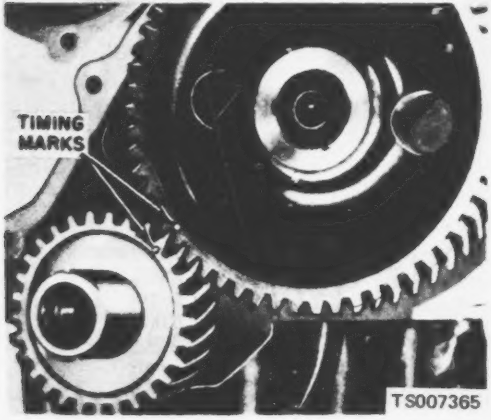


Figure 6-36. Timing Gear Aligning Marks.

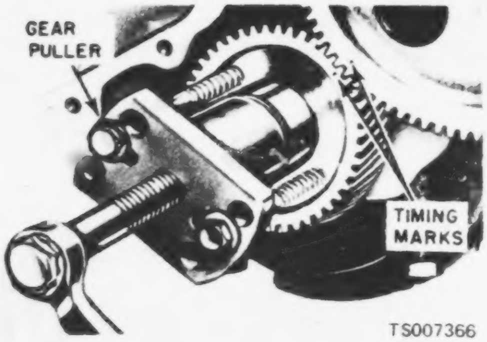


Figure 6-37. Removing Crankshaft Gear.

(10) Remove the main bearing caps and bearings.

(11) Carefully lift the crankshaft out of the cylinder block so that the thrust bearing surfaces are not damaged. Handle the crankshaft with care to avoid possible fracture or damage to the finished surfaces.

(12) Refer to paragraph 6-30 for the cleaning and inspection procedures. Be sure the oil seal surfaces on the crankshaft and crankshaft damper are properly cleaned.

b. Installation.

(1) Remove the main bearing inserts from the block and bearing caps.

(2) Remove the bearing inserts from the connecting rod caps.

(3) Clean the crankshaft rear oil seal recess in the cylinder block and rear main bearing cap.

(4) If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearings. Be sure the bearing inserts and bearing bores are clean. Foreign material under the inserts will distort the bearing and cause a failure.

(5) Place the upper main bearing inserts in position in the bore with the tang fitting in the slot provided. Be sure the oil holes in the bearing inserts are aligned with the oil holes in the cylinder block transverse webs.

(6) Install the lower main bearing inserts in the bearing caps with the tang fitted in the slot.

(7) Carefully lower the crankshaft into place. Be careful not to damage the bearing surfaces.

(8) Check the clearance of each main bearing following procedures given in paragraph 6-33

under Fitting Main and Connecting Rod Bearings.

(9) After the bearings have been installed, apply a light coat of heavy engine oil to the journals and bearings. Install all the bearing caps, except the thrust bearing cap (No. 5 bearing). Be sure that the main bearing caps are installed in their original locations. Torque the bearing cap bolts to specifications.

(10) Install the thrust bearing cap with the bolts finger-tight.

(11) Pry the crankshaft forward against the thrust surface of the upper half of the bearing (fig. 6-38).

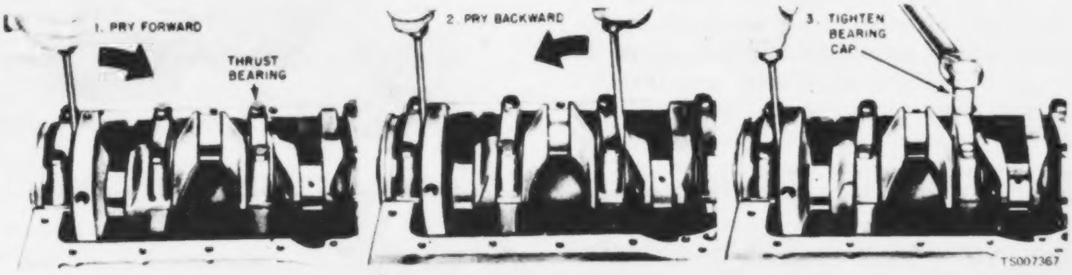


Figure 6-38. Aligning Thrust Bearings.

(12) Hold the crankshaft forward and pry the thrust bearing cap to the rear. This will align the thrust surfaces of both halves of the bearing.

(13) Retain the forward pressure on the crankshaft. Torque the cap bolts to specifications (table 6-6).

(14) Check the crankshaft end play (para 6-34).

(15) If the end play exceeds the wear limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks or foreign matter. If the thrust faces are not damaged or dirty, they probably need realigning. Install the thrust bearing and align the faces following the recommended procedure (steps 8 through 11). Then check the end play.

(16) Coat a new crankshaft rear oil seal with oil and install it (fig. 6-39). Inspect the seal to be sure it was not damaged during installation.

Table 6-6. Crankshaft, Connecting Rod and Bearing Specifications

ITEM	INCHES
CRANKSHAFT	
Main bearing journal diameter	2.3982-2.3990
Maximum out-of-round	0.0004
Wear limit	0.005
Main bearing journal runout maximum	0.002
Maximum journal taper (per inch)	0.0003
Thrust bearing journal length	1.199-1.201
Connecting rod journal diameter	2.1228-2.1236
Crankshaft end play	0.004-0.008
Crankshaft to rear face of block runout	0.005 T.I.R.
Flywheel ring gear lateral runout	0.040
CONNECTING ROD	
Piston pin bushing I.D.	0.9734-0.9742
Rod bearing bore diameter	2.2750-2.2758
maximum out-of-round	0.0006
maximum taper	0.0004
Center-to-center length	6.7932-6.7962
Maximum twist	.012
Maximum bend	.004
Side clearance (assembled to crankshaft)	0.0060-0.0130
BEARINGS	
Connecting rod (wall thickness-std)	0.0754-0.0757
desired clearance	0.0008-0.0015
allowable clearance	0.0008-0.0024
Main bearings (wall thickness-std)	0.0954-0.0957
desired clearance	0.0005-0.0015
allowable clearance	0.0005-0.0022

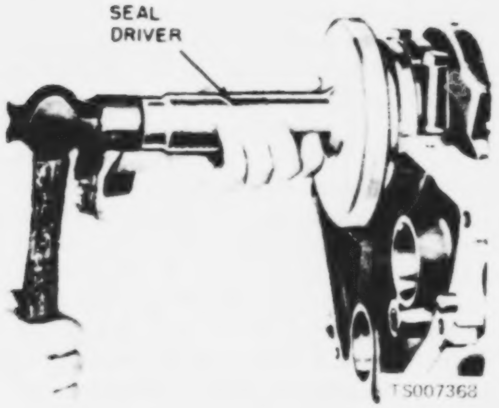


Figure 6-39. Installing Crankshaft Rear Seal.

(17) Install the bearing inserts in the connecting rods and caps. Check the clearance of each bearing following the procedure under Connecting Rod bearing Replacement, paragraph 6-33.

(18) If the bearing clearances are to specifications, apply a light coat of engine oil to the journals and bearing.

(19) Turn the crankshaft throw to the bottom of its stroke and pull the piston all the way down until the connecting rod bearing seats on the crankshaft journal.

(20) Install the connecting rod cap and torque the nuts to specifications.

(21) After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal (fig. 6-33).

(22) Clean the oil pan, oil pump and oil pump screen.

(23) Install the inlet tube and screen on the oil pump. Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening. Install it with a new gasket. Torque the attaching bolts to specifications.

(24) Turn the engine on the work stand so that the rear of the engine is up. Position the engine rear cover plate on the cylinder block. Position the flywheel on the crankshaft. Coat the threads of the attaching bolts with oil-resistant sealer and install the bolts. Torque the bolts to specifications.

(25) Turn the engine on the work stand so that the front end is up.

(26) Install the crankshaft gear following the procedure under Timing Gear Installation, paragraph 6-39.

(27) Install a new crankshaft front oil seal in the cylinder front cover (fig. 6-40). Install the cylinder front cover and crankshaft damper by following the procedure outlined under Cylinder Front Cover Installation, paragraph 6-36.

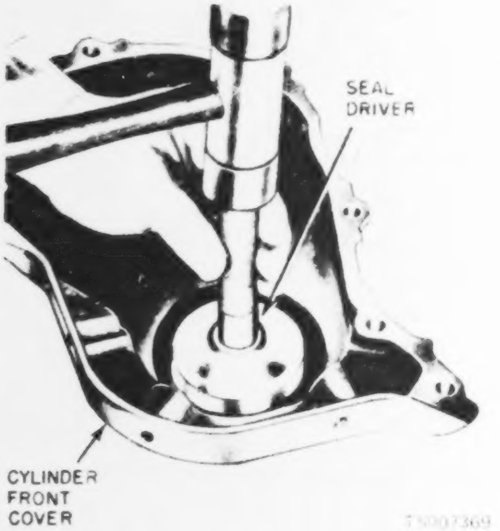


Figure 6-40. Installing Crankshaft Front Oil Seal.

(28) Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (fig. 6-41). Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal. Install new side gaskets on the oil pan with oil-resistant sealer (fig. 6-42). Position a new oil pan to cylinder front cover seal on the oil pan and install the oil pan.

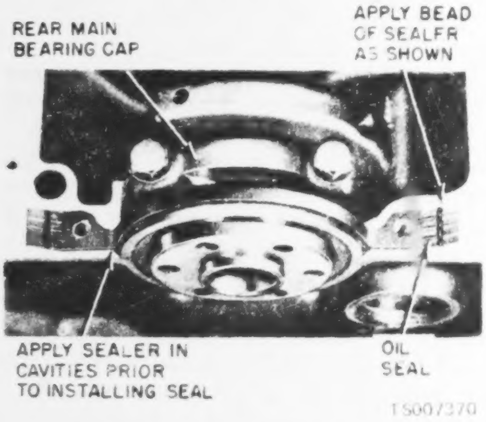


Figure 6-41. Installing Oil Pan Rear Seal.

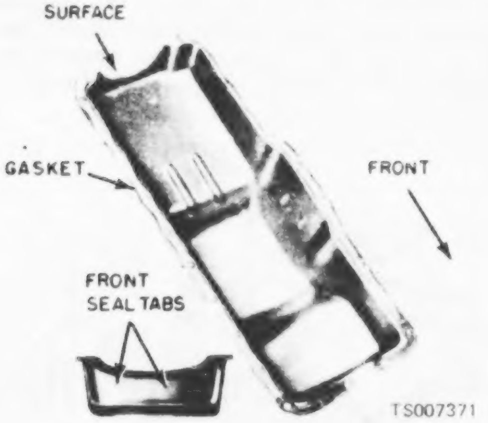


Figure 6-42. Oil Pan Gaskets and Seal.

6-30. Crankshaft Cleaning and Inspection

a. Cleaning.

(1) Clean the crankshaft by rinsing in a bath of solvent, Federal Specification P-D-680. Blow out all oil passages with compressed air.

NOTE

Handle the crankshaft very carefully to avoid possible fractures or damage to the finished bearing surfaces.

(2) Clean the oil seal surface at the rear of the crankshaft with solvent to remove any corrosion, sludge or varnish deposits. Excessive deposits not readily removed with solvent may be removed with crocus cloth.

(3) Use crocus cloth to remove any sharp edges, burrs or other imperfections which might damage the oil seal during installation or cause premature seal wear.

CAUTION

Do not use crocus cloth to the extent that the seal surfaces become polished. A finely polished surface may produce poor sealing or cause premature seal wear.

(4) Clean the oil seal contact surface on the crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits that are not readily removed with solvent may be removed with crocus cloth.

b. Inspection.

(1) Inspect the main and connecting rod journals for cracks, scratches, grooves or scores.

(2) Measure the diameter of each journal at least four places to determine out-of-round, taper or undersize condition (fig. 6-43). Refer to table 6-6 for specifications.

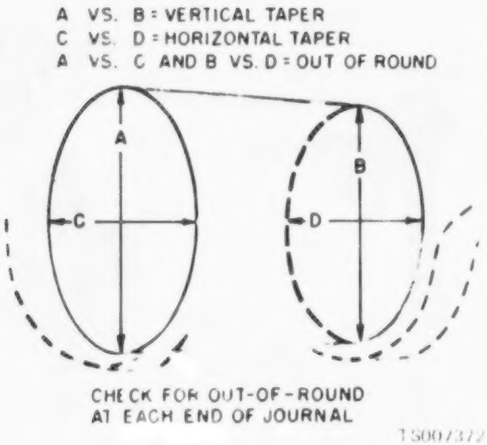


Figure 6-43. Journal Measurements.

(3) Inspect the rear oil seal surface of the crankshaft for excessively deep grooves, nicks, burrs, porosity, or scratches which could damage the oil seal lip during installation. Remove all nicks and burrs and polish the chamfered edge and oil seal contact surface with crocus cloth.

(4) Inspect the crankshaft damper or sleeve oil seal surface for nicks, sharp edges or burrs that might damage the oil seal during installation or cause premature seal wear.

6-31. Connecting Rods Cleaning and Inspection

a. Cleaning. Remove the bearings from the rod and cap. Identify the bearings if they are to be used again. Clean the connecting rod in solvent, including the rod bore and the back of the inserts. Do not use a caustic cleaning solution. Blow out all passages with compressed air.

b. Inspection.

(1) The connecting rods and related parts should be carefully inspected and checked for conformance to specifications. Various forms of engine wear caused by these parts can be readily identified.

(2) A shiny surface on the pin boss side of the piston usually indicates that a connecting rod is bent or the piston pin hole is not in proper relation to the piston skirt and ring grooves.

(3) Abnormal connecting rod bearing wear can be caused by either a bent connecting rod, an improperly machined journal, or a tapered connecting rod bore.

(4) Twisted connecting rods will not create an easily identifiable wear pattern, but badly

twisted rods will disturb the action of the entire piston, rings, and connecting rod assembly and may be the cause of excessive oil consumption.

(5) Inspect the connecting rods for signs of fractures and the bearing bores for out-of-round and taper. If the bore exceeds the maximum limit and/or if the rod is fractured, it should be replaced.

(6) On connecting rods that have a piston pin bushing, check the piston pin to connecting rod bushing clearance. Replace the connecting rod if the bushing is so worn that it cannot be reamed or honed for an oversize pin.

(7) Check the ID of the connecting rod piston pin bore. Replace the connecting rod if the pin bore is not within specifications. Replace defective connecting rod nuts and bolts.

(8) After the connecting rods are assembled to the piston, check the rods for bend or twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. If the bend and/or twist exceeds specification, the rod must be straightened or replaced.

6-32. Main and Connecting Rod Bearings Cleaning and Inspection

a. Cleaning. Clean the bearing inserts and caps thoroughly in solvent, and dry them with compressed air. Do not scrape gum or varnish deposits from bearing shells.

b. Inspection. Inspect each bearing carefully. Bearings that have a scored, chipped, or worn surface should be replaced. Typical examples of bearings that should be replaced and the causes are shown in figure 6-44. The copper-lead bearing base may be visible through the bearing overlay. This does not mean that the bearing is worn. It is not necessary to replace the bearing if the bearing clearance is within recommended limits. Check the clearance of bearings that appear to be satisfactory with Plastigage. Fit new bearings following the recommended procedure in paragraph 6-33.

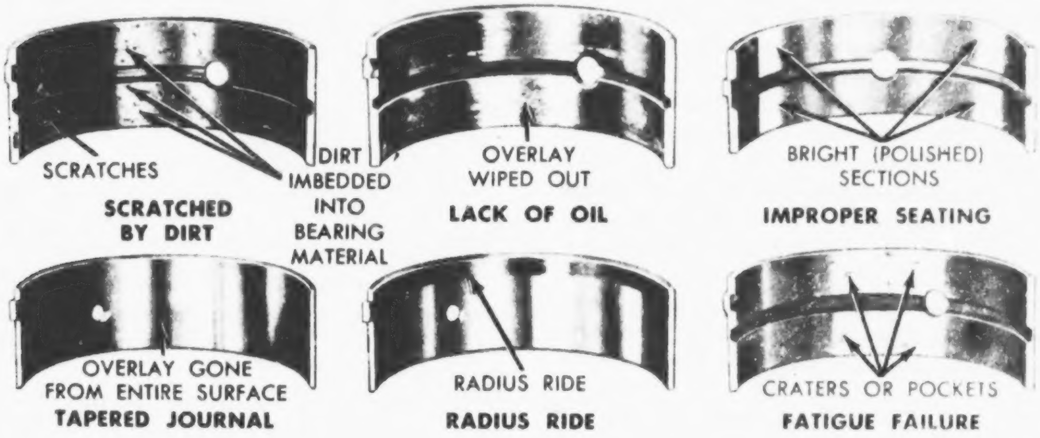


Figure 6-44. Typical Bearing Failures.

6-33. Fitting Main and Connecting Rod Bearings

a. Set-up.

(1) Clean crankshaft journals. Inspect journals and thrust faces (thrust bearing) for nicks, burrs or bearing pick-up that would cause premature bearing wear. When replacing standard bearings with new bearings, it is good practice to fit the bearing to minimum specified clearance. If the desired clearance cannot be obtained with a standard bearing, try one-half of an 0.001 or 0.002 inch undersize in combination with a standard bearing to obtain the proper clearance.

(2) If fitting a main bearing, position a jack under counterweight adjoining bearing which is being checked. Do not place jack under front post of crankshaft. Support crankshaft with jack so its weight will not compress Plastigage and provide an erroneous reading.

b. Use of Plastigage.

(1) Place a piece of Plastigage on bearing surface across full width of bearing cap and about ¼ inch off center (fig. 6-45).

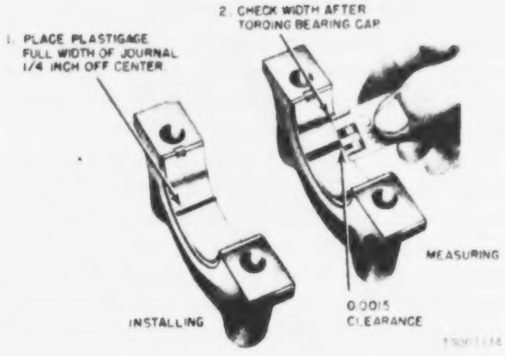


Figure 6-45. Fitting Bearings with Plastigage.

(2) Install cap and torque bolts to specifications. Do not turn crankshaft while Plastigage is in place.

(3) Remove cap. Using Plastigage scale, check width of Plastigage at widest point to get minimum clearance. Check at narrowest point to get maximum clearance. Difference between readings is taper of journals. See table 6-6.

(4) If clearance exceeds specified limits, try 0.001 or 0.002 inch undersize bearings in combination with the standard bearings. Bearing clearance must be within specified limits. If 0.002 undersize main bearings are used on more than one journal, be sure they are all installed in cylinder block side of bearing. If standard and 0.002 inch undersize bearings do not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.

(5) After bearing has been fitted, apply light coat of engine oil to journal and bearings. Install bearing cap. Torque cap bolts to specifications (table 6-3).

(6) Repeat procedures for remaining bearings that require replacement.

6-34. Crankshaft End Play and Flywheel Runout Check

a. Crankshaft End Play.

(1) Force the crankshaft toward the rear of the engine.

(2) Install a dial indicator so that the contact point rests against the crankshaft flange and the indicator axis is parallel to the crankshaft axis (fig. 6-46).

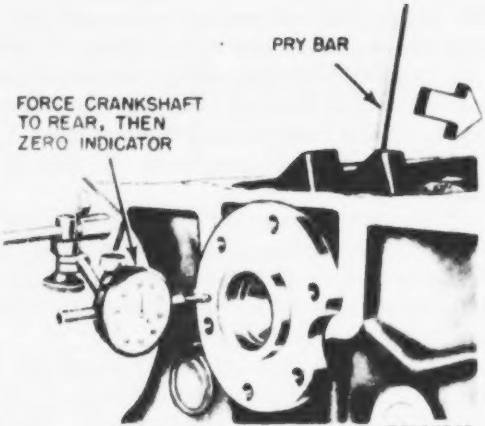


Figure 6-46. Checking Crankshaft End Play.

(3) Zero the dial indicator. Push the crankshaft forward and note the reading on the dial.

(4) If the end play exceeds the wear limit, replace the thrust bearing. If the end play is less than the minimum limit, inspect the thrust bearing faces for scratches, burrs, nicks, or dirt. If the thrust faces are not damaged or dirty, they probably were not aligned properly. Install the thrust bearing and align the faces following the procedure recommended under paragraph 6-29.

b. Flywheel Runout.

(1) Remove the spark plugs.

(2) Install a dial indicator so that the indicator point rests on the face of the ring gear adjacent to the gear teeth.

(3) Push the flywheel and crankshaft forward or backward as far as possible to prevent crankshaft end play from being indicated as flywheel runout.

(4) Set the indicator dial on the zero mark. Turn the flywheel one complete revolution while observing the total indicator reading (TIR). If the TIR exceeds specifications, the flywheel and ring gear assembly must be replaced. See table 6-6.

6-35. Crankshaft Rear Oil Seal

If the crankshaft rear oil seal replacement is the only operation being performed, it can be done in the vehicle as detailed in the following procedure. If the oil seal is being replaced in conjunction with a rear main bearing replacement, the engine must be removed from the vehicle and installed on a work stand (fig. 6-3).

a. Removal.

(1) Remove the starter.

(2) Remove the transmission from the vehicle, following the procedures in Chapter 2, Section IV.

(3) Remove the flywheel attaching bolts and remove the flywheel and engine rear cover plate.

(4) Use an awl to punch two holes in the crankshaft rear oil seal. Punch the holes on opposite sides of the crankshaft and just above the bearing cap to cylinder block split line. Install a sheet metal screw in each hole. Use two large screwdrivers or small pry bars and pry against both screws at the same time to remove the crankshaft rear oil seal. It may be necessary to place small blocks of wood against the cylinder block to provide a fulcrum point for the pry bars. Use caution throughout this procedure to avoid scratching or otherwise damaging the crankshaft oil seal surface.

(5) Clean the oil seal recess in the cylinder block and main bearing cap.

b. Installation.

(1) Clean, inspect and polish the rear oil seal rubbing surface on the crankshaft, following the procedures in paragraph 6-30. Coat a new oil seal and the crankshaft with a light film of engine oil. Start the seal in the recess and install it with the tool as shown in figure 6-40. Keep the tool straight with the centerline of the crankshaft and install the seal until the tool contacts the cylinder block surface. Remove the tool and inspect the seal to be sure it was not damaged during installation.

(2) Install the engine rear cover plate. Position the flywheel on the crankshaft flange. Coat the threads of the flywheel attaching bolts with oil-resistant sealer and install the bolts. Torque the bolts in sequence across from each other to specifications.

(3) Install the transmission, following the procedure in Chapter 2, Section IV. Do not adjust the transmission linkage.

6-36. Cylinder Front Cover and Front Oil Seal

a. Removal.

(1) Drain the cooling system and crankcase.

(2) Remove the radiator.

(3) Remove the alternator adjusting arm bolt, loosen the drive belt and swing the adjusting arm out of the way. Remove the fan, drive belts and pulley. It may be necessary to remove the air compressor belt and/or steering pump belt.

(4) Remove the cam screw and washer from the end of the crankshaft and remove the damper (fig. 6-35).

(5) Remove the oil level dipstick. Remove the oil pan and related parts by following the procedure under Oil Pan Removal, paragraph 6-43. Remove the oil pump screen and inlet tube assembly.

(6) Remove the cylinder front cover and discard the gasket. It is good practice to replace the oil seal each time the cylinder front cover is removed.

(7) Drive out the old seal with a pin punch. Clean out the recess in the cover.

b. Installation.

(1) Coat a new seal with grease and install the seal (fig. 6-40). Drive the seal in until it is fully seated in the recess. After installation, check to be sure the seal is properly positioned in the cover and the spring is properly positioned in the seal.

(2) Clean the cylinder front cover and the gasket surfaces of the cylinder block. Coat the gasket surface of the block and cover with oil-resistant sealer. Position a new gasket on the block.

(3) Insert the small diameter end of the cover alignment tool in the bore of the cover. Position the cover and pilot assembly over the end of the crankshaft and against the block (fig. 6-47), being careful to align the cover flush with the cylinder block oil pan gasket surface. Install the alternator adjusting arm and cylinder front cover bolts. Torque all the bolts to specifications.

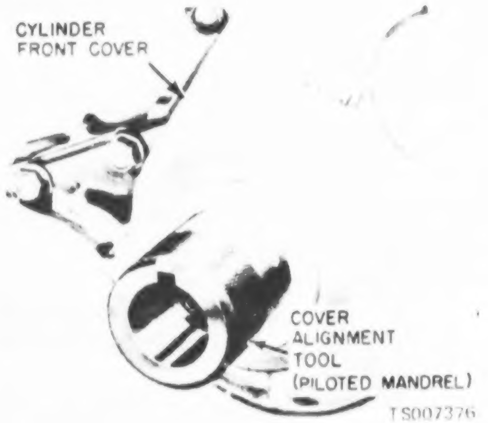


Figure 6-47. Aligning Cylinder Front Cover.

(4) Lubricate the crankshaft with a white lead and oil mixture to facilitate installation and removal of the damper. Lubricate the front oil seal rubbing surface on the damper inner hub and the inner surface (sealing area) of the oil seal with Lubriplate or equivalent.

(5) Align the damper keyway with the key on the crankshaft. Install the damper on the crankshaft as shown in figure 6-48.

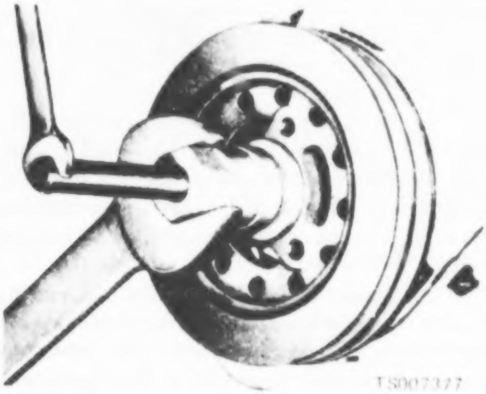


Figure 6-48. Installing Crankshaft Damper.

(6) Install the washer and capscrew. Torque the capscrew to specifications.

(7) Apply oil-resistant sealer to the cavities between the rear main bearing cap and cylinder block (fig. 6-42). Install a new oil pan rear seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.

(8) Install new side gaskets on the oil pan with oil-resistant sealer (fig. 6-42). Position a new cylinder front cover seal on the oil pan.

(9) Clean and install the oil pump screen and inlet tube assembly. Install the oil pan and related parts following the procedure under Oil Pan Installation. Install the oil level dipstick.

Section VIII. CAMSHAFT AND TIMING GEARS

6-37. General

The camshaft is supported by four bearings, pressed into the cylinder block. The camshaft is driven by a timing gear, pressed onto the camshaft, in mesh with a gear on the crankshaft. Camshaft thrust is controlled by a thrust plate located between the camshaft gear and the front journal on the camshaft. An eccentric, made integral with the camshaft, operates the fuel pump. A gear is cast integrally with the camshaft to drive the distributor and the oil pump. The camshaft and related parts are shown in figure 6-49.

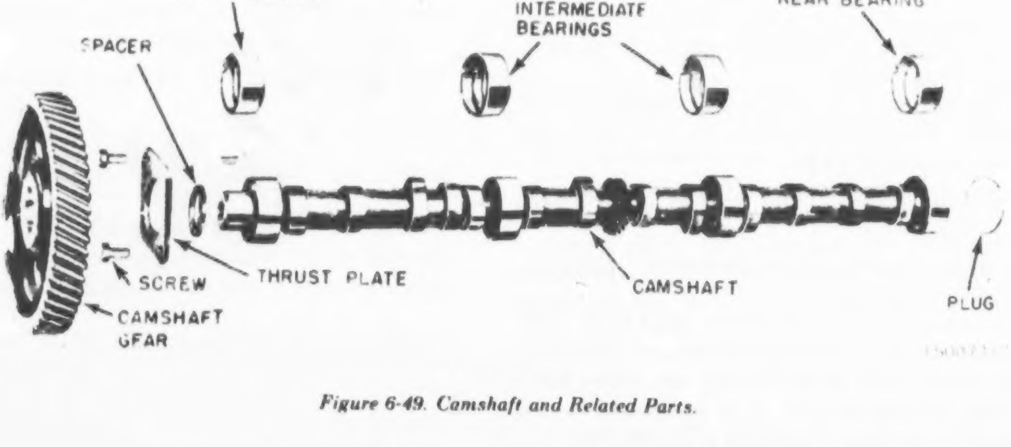


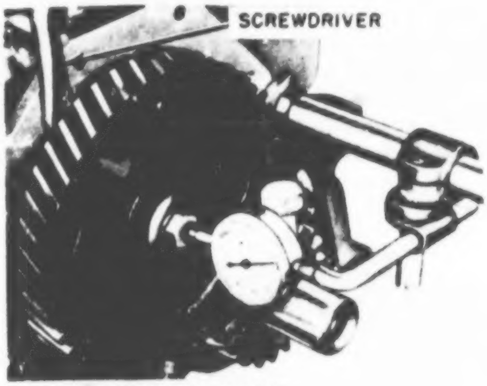
Figure 6-49. Camshaft and Related Parts.

6-38. Camshaft End Play and Timing Gear Checks

a. End Play Check.

(1) Remove the crankshaft damper and cylinder front cover. (See procedures in Section VII.)

(2) Push the camshaft toward the rear of the engine. Install a dial indicator so that the indicator point is on the camshaft gear attaching screw (fig. 6-50).



1. PUSH CAMSHAFT TO REAR OF ENGINE.
2. SET INDICATOR TO ZERO
3. PRY CAMSHAFT FORWARD AND READ DIAL.

TS007379

Figure 6-50. Checking Camshaft End Play.

(3) Zero the dial indicator. Position a large screwdriver between the camshaft gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with the specifications of table 6-7.

(4) If the end play is excessive, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate.

(5) Remove the dial indicator.

b. Timing Gear Backlash Check.

(1) Install a dial indicator on the cylinder block as shown in figure 6-51.

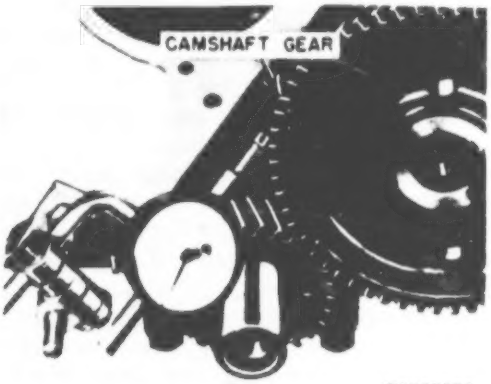


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Figure 6-51. Checking Timing Gear Backlash.

Table 6-7. Camshaft and Timing Gear Specifications

ITEM	INCHES
CAMSHAFT	
Lobe lift - intake	0.2490
Lobe lift - exhaust	0.2490
Lobe lift - allowable wear	0.005
End play	0.001-0.007
End play - wear limit	0.009
Journal to bearing clearance	0.001-0.003
Journal to bearing clearance - wear limit	0.006
Journal runout - maximum	0.008
Journal out-of-round - maximum	0.005
BEARINGS	
Journal diameter - std	2.0170-2.0180
Bearing inside diameter	2.0190-2.0200
No. 1 bearing setback	0.020-0.035
TIMING GEAR	
Backlash	0.002-0.004
Camshaft gear face runout	0.006 TIR
Crankshaft gear face runout	0.003 TIR

(2) Turn the camshaft gear counterclockwise by hand to take up backlash and set the indicator to zero with the plunger against one gear tooth.

(3) Hold the camshaft gear firmly against the block and rotate the gear clockwise to obtain backlash reading. Refer to table 6-7 for backlash limits.

c. Timing Gear Runout.

(1) Install dial indicator to the cylinder block as shown in figure 6-52.

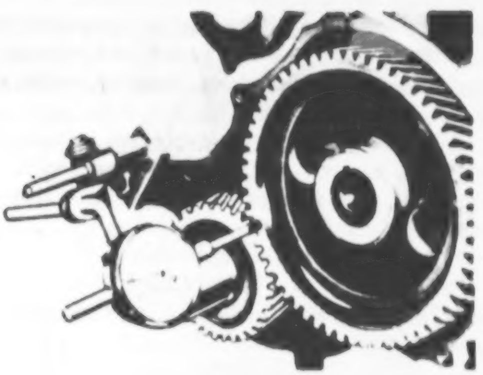

Figure 6-52. Checking Timing Gear Runout.

(2) Hold the camshaft gear against the thrust plate, and zero the indicator.

(3) Rotate the crankshaft to turn the camshaft, while holding the camshaft gear against the thrust plate.

(4) Check gear runout through one complete revolution of the camshaft.

(5) If the gear runout exceeds specifications, remove it and check for burrs or foreign particles on or between the camshaft and gear joining flanges. Check the runout. If it still exceeds specifications, replace both gears.

(6) Follow the above procedure to check crankshaft gear runout.

6-39. Camshaft Removal and Installation

a. Removal.

(1) Disconnect the spark plug wires at the spark plugs and disconnect the secondary high tension wire at the ignition coil. Remove the distributor cap and spark plug wires as an assembly.

(2) Disconnect the fuel outlet lines at the fuel pump. Remove the fuel pump mounting bolts and position the fuel pump out of the way.

(3) Disconnect the vacuum line at the distributor and the primary wire at the coil. Remove the distributor.

(4) Remove the valve rocker arm cover. Loosen the rocker arm stud nuts, move the rocker arms to one side and remove the pushrods in sequence. Place the pushrods in a rack so they can be installed in their original locations.

(5) Remove the valve pushrod cover; then remove the valve lifters in sequence, using the tool shown in figure 6-6. Place the valve lifters in a tray or rack to facilitate installation in the same sequence in which they were removed.

(6) Remove the capscrew and washer from the end of the crankshaft. Remove the damper (fig. 6-35).

(7) Remove the oil pan and related parts by following the procedure under paragraph 6-43. Remove the oil pump screen and inlet tube assembly.

(8) Remove the cylinder front cover and discard the gasket.

(9) Check the camshaft end play, the timing gear backlash and the timing gear runout (para 6-38).

(10) Turn the crankshaft to align the timing marks as shown in figure 6-36.

(11) Remove the camshaft thrust plate screws (fig. 6-53). Remove the camshaft. Avoid damaging the camshaft lobes during removal. Press the camshaft out of the gear in an arbor press (fig. 6-54). Remove the key, thrust plate and spacer.

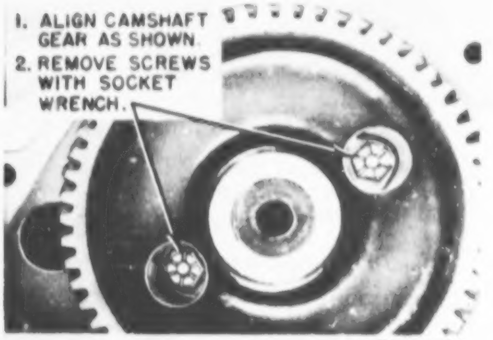
1. ALIGN CAMSHAFT GEAR AS SHOWN.
2. REMOVE SCREWS WITH SOCKET WRENCH.
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Figure 6-53. Thrust Plate Screws.

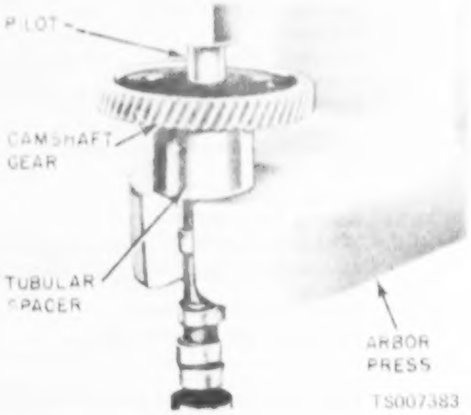

Figure 6-54. Removing Camshaft Gear.

b. Installation. If the camshaft end play, timing gear backlash and/or timing gear runout were excessive, make the necessary corrections before installing the camshaft.

(1) Oil the camshaft bearing journals and apply Lubriplate or equivalent to all the lobes.

(2) Install the camshaft, gear and thrust plate as an assembly, making sure that the timing marks are in alignment (fig. 6-36).

(3) Torque the thrust plate attaching screws to specifications (see table 6-3).

(4) Position the camshaft gear on the camshaft. Align the timing marks on the timing gears as shown in figure 6-36. Install the camshaft gear with the tool shown in figure 6-55. Be sure the gear and spacer are tight against the shoulder on the camshaft.

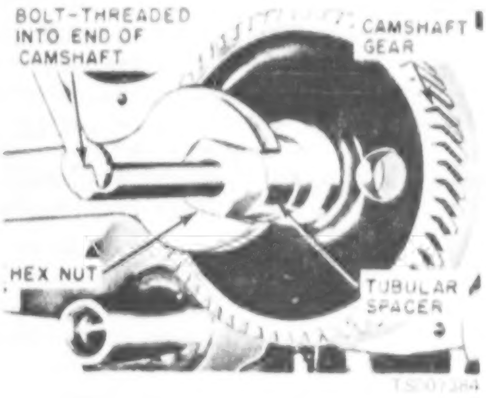

Figure 6-55. Installing Camshaft Gear.

(5) Crank the engine until the timing marks are aligned. Do not turn the crankshaft again until the distributor is installed.

(6) Clean the cylinder front cover and cylinder block gasket surfaces. Install a new oil seal in the cylinder front cover. Clean the crankshaft damper and inspect it, following the procedures in paragraph 6-30. Install the cylinder front cover and damper following paragraph 6-36.

(7) Clean the oil pump screen. Clean the oil pan and the gasket surfaces of the cylinder block. Install the oil pump screen and inlet tube and oil pan, following the procedures under Oil Pan Installation, paragraph 6-43.

(8) Lubricate the valve lifters with heavy engine oil and install the lifters (fig. 6-6) in the same bores from which they were removed. Apply Lubriplate or equivalent to both ends of the pushrods and install the pushrods in the same sequence that they were removed. Be sure the pushrods were seated in the valve lifter sockets.

(9) Clean the valve pushrod cover and cylinder block gasket surfaces. Apply oil-resistant sealer to one side of a new gasket and place the gasket on the pushrod cover with the cemented side next to the cover. Install the cover and torque the bolts in sequence to specifications.

(10) Apply Lubriplate or equivalent to the valve pad on the rocker arms. Oil the valve stems with heavy engine oil. Align the valve rocker arms with the valves and pushrods. Tighten the rocker arm stud nuts sufficiently to hold the pushrods in place. Adjust the valve clearance following instructions given in TM 10-3930-633-12.

(11) Clean the valve rocker arm cover and cylinder head gasket surface. Place the new gasket in the cover making sure that the tabs of the gasket engage the notches provided in the cover. Install the cover and torque the screws in sequence to specifications.

(12) Set the distributor rotor so the points are about to open for No. 1 cylinder firing position. Install the distributor. Check the points. If the camshaft timing marks are still aligned (step 6 above), the points should be fully open in No. 1 cylinder firing position. If the points are not open, remove the distributor and rotate the shaft in the proper direction. Install the distributor and hold-down clamp.

(13) Install the distributor cap and spark plug wires as an assembly. Connect the spark plug wires to the plugs and the secondary high tension wire to the coil.

6-40. Camshaft and Timing Gears Cleaning and Inspection

a. Cleaning.

(1) Clean the camshaft in a bath of solvent, Federal Specification P-D-680, and wipe dry.

(2) Clean timing gears in solvent bath and dry with compressed air.

b. Inspection.

(1) Inspect the gear teeth for scores, nicks, etc. Note the condition of the teeth contact pattern. If the teeth are scored, replace the gears.

(2) It is not necessary to replace the gears in sets. Replace the camshaft gear and check the backlash, runout, etc., to determine if the crankshaft gear should be replaced.

(3) Inspect the camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in the general area of the lobe toe. This pitting is not detrimental to the operation of the camshaft; therefore, the camshaft should not be replaced

unless the camshaft lobe lift loss has exceeded 0.005 inch.

(4) The lift of camshaft lobes can be checked with the camshaft installed in the engine or on centers. Refer to Camshaft Lobe Lift Check, paragraph 6-41.

(5) Check the distributor drive gear for broken or chipped teeth.

(6) Check the fuel pump eccentric for grooving or obvious wear.

(7) Minor scoring or nicks may be dressed out with an oilstone. However, if journals are severly marred or worn beyond the wear limit, replace the camshaft.

6-41. Camshaft Lobe Lift Check

NOTE

The procedure following is for checking lobe lift with camshaft installed. Lobe lift may be checked with camshaft between centers by setting up the dial indicator so that it bears directly on the camshaft lobe.

a. Set-Up.

(1) Remove rocker arm cover. Remove rocker arm stud nut, fulcrum seat and rocker arm. Use an adapter as illustrated (fig. 6-56) for ball end pushrods.

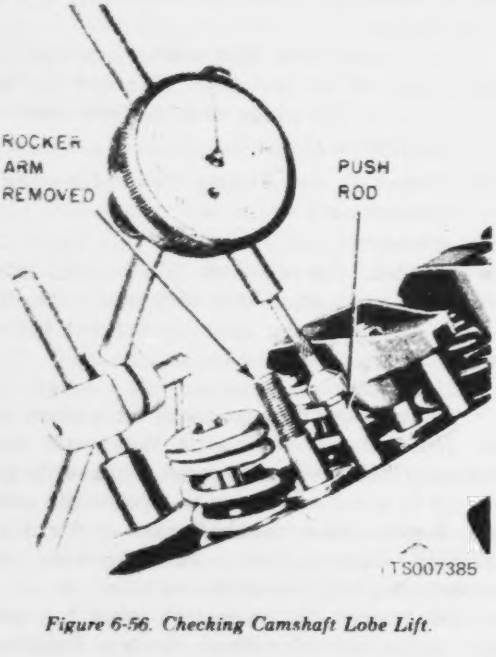

Figure 6-56. Checking Camshaft Lobe Lift.

(2) Make sure the pushrod is in the valve lifter socket. Install a dial indicator so that the actuating point of the indicator is in the pushrod socket (or the indicator ball socket adapter is on the end of the pushrod) and in the same plane as the pushrod movement.

(3) Disconnect the brown lead (I terminal) and the red and blue lead (S terminal) at the starter relay. Install an auxiliary starter switch between the battery and S terminals of the starter relay. Crank the engine with the ignition switch OFF.

b. Procedure.

(1) Using auxiliary starter switch, turn the crankshaft over until the tappet or lifter is on the base circle of the camshaft lobe. At this point, the pushrod will be in its lowest position.

(2) Zero the dial indicator. Continue to rotate the crankshaft slowly until the pushrod is in the fully raised position.

(3) Compare the total lift recorded on the indicator with specifications (table 6-7).

(4) To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits, the camshaft and the valve lifters operating on the worn lobe(s) must be replaced.

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Section IX. OIL PAN AND OIL PUMP

6-42. General

a. Oil from the oil pan sump is forced through the pressure type lubrication system by the rotor-type oil pump. A spring loaded relief valve in the pump directs excess oil back to the intake side of the pump.

b. A full-flow disposable filter element filters the entire output of the pump before the oil enters the engine. A by-pass valve permits flow around the filter if it becomes clogged.

c. From the filter, oil flows into the main oil gallery. From this gallery oil is supplied to the camshaft and main bearings, to each hydraulic lifter, to the crankshaft and connecting rods, and the timing gears. A drilled passage in the block supplies oil to the distributor shaft, and the valve train is lubricated by oil from the lifter chamber passing upward through the pushrods.

6-43. Oil Pan Removal and Installation

a. Removal.

(1) Drain the crankcase.

(2) Remove the oil pan attaching screws and remove the oil pan.

b. Installation.

(1) Clean the gasket surfaces of the oil pump, oil pan and cylinder block. Remove the rear main bearing cap to oil pan seal and cylinder front cover to oil pan seal. Clean the seal grooves.

(2) Apply oil-resistant sealer in the cavities between the bearing cap and cylinder block (fig. 6-41). Install a new seal in the rear main bearing cap and apply a bead of oil-resistant sealer to the tapered ends of the seal.

(3) Install new side gaskets on the oil pan with oil resistant sealer (fig. 6-42). Position a new oil pan to cylinder front cover seal on the oil pan.

(4) Clean the inlet tube and screen assembly and place it in the oil pan, if previously removed.

(5) Position the oil pan under the engine. Install the inlet tube and screen assembly on the oil pump with a new gasket. Torque the screws to specifications. Position the oil pan against the cylinder block and install the attaching bolts. Torque the bolts in sequence to specifications. See table 6-3.

6-44. Oil Pump Removal and Installation

a. Removal.

(1) Remove the oil pan as described in paragraph 6-43. The oil pump will be exposed as shown in figure 6-57.

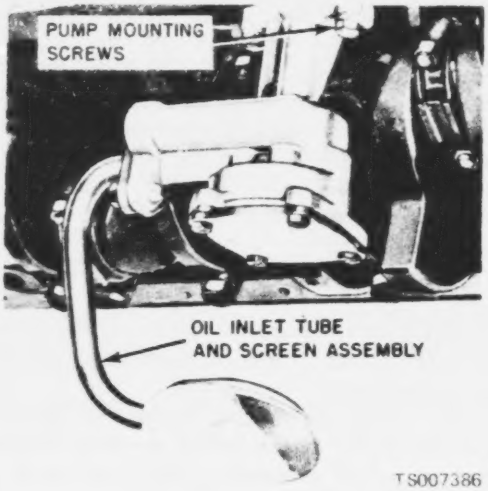


Figure 6-57. Oil Pump Installed.

(2) Remove the oil pump attaching screws and remove the pump from the cylinder block.

b. Installation.

(1) Prime the oil pump by filling the inlet opening with oil and rotate the pump shaft until oil emerges from the outlet opening.

(2) Coat a new oil pump gasket with oil-resistant sealer and position it on the oil pump.

(3) Install the oil pump on the cylinder block. Torque the attaching bolts to specifications.

6-45. Oil Pump Repair

a. Disassembly.

(1) Remove the cover attaching screws and remove the cover (fig. 6-58).

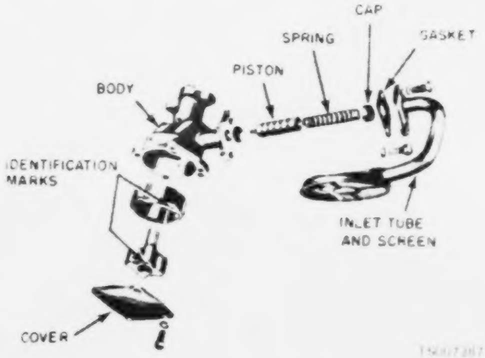


Figure 6-58. Oil Pump Disassembled.

(2) Remove the inner rotor and shaft assembly, then remove the outer race.

(3) Scrape away the staking marks on the body around the oil pressure relief valve cap. Drill a 1/8-inch hole in the relief valve cap and insert a self-threading sheet metal screw of proper diameter into the cap. Pull the cap out of the chamber. Remove the spring and plunger.

b. Cleaning. Wash all parts in a solvent and dry them thoroughly with compressed air. Use a brush to clean the inside of the pump housing and the pressure relief valve chamber. Be sure all dirt and metal particles are removed.

c. Inspection.

(1) Refer to table 6-8 for clearances and wear limits.

(2) Check the inside of the pump housing and the outer race and rotor for damage or excessive wear or scoring.

(3) Check the mating surface of the pump cover for wear. If the cover mating surface is worn, scored or grooved, replace the cover.

(4) Measure the outer race to housing clearance (fig. 6-59).

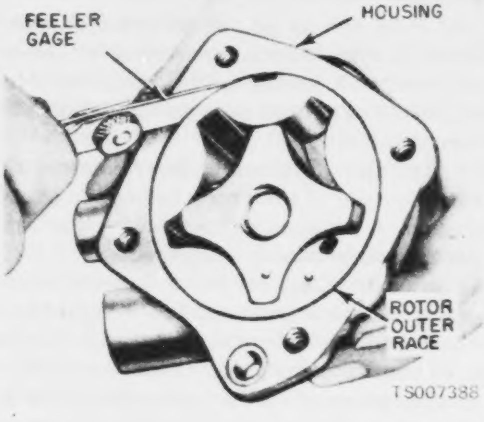


Figure 6-59. Measuring Outer Race Clearance.

Table 6-8. Oil Pump Specifications

ITEM	SPECIFICATION
Relief valve spring tension	20.6 - 22.6 lb at 2.490 length
Drive shaft-to-housing clearance	0.0015-0.0029 in.
Relief valve clearance	0.0015-0.0029 in.
Rotor end play	0.0010-0.0040 in.
Outer race-to-housing clearance	0.001-0.013 in.

(5) With the rotor assembly installed in the housing, place a straightedge over the rotor assembly and the housing. Measure the clearance (rotor end play) between the straightedge and the rotor and outer race (fig. 6-60). The outer race, shaft and rotor are replaceable only as an assembly.

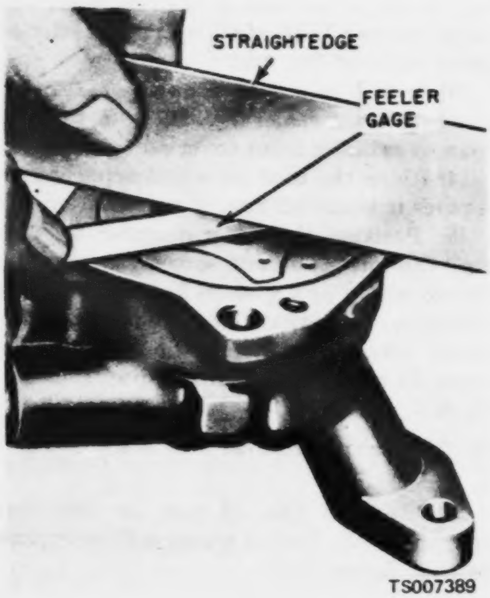


Figure 6-60. Measuring Rotor End Play.

(6) Check the drive shaft to housing bearing clearance by measuring the OD of the shaft and the ID of the housing bearing.

(7) Inspect the relief valve spring for a collapsed or worn condition. Check the relief valve spring tension. If the spring tension is not within specifications and/or the spring is worn or damaged, replace the spring.

(8) Check the relief valve piston for scores and free operation in the bore.

d. Assembly.

(1) Clean all parts thoroughly. Install the oil pressure relief valve plunger, spring and new cap. Stake the cap into position.

(2) Install the outer race (recessed dot facing out on same side as dot on rotor) and the inner rotor and shaft assembly.

NOTE

The inner rotor and shaft and the outer race are serviced as an assembly. One part should not be replaced without replacing the other.

(3) Install the cover and torque the attaching screws to specifications.

6-46. Oil Pan Cleaning and Inspection

a. Cleaning.

(1) Scrape any dirt or metal particles from inside the pan.

(2) Scrape all gasket material from mounting flange.

(3) Wash the pan in solvent, Federal Specification P-D-680, and dry thoroughly.

NOTE

Make certain that all foreign particles are removed from below the baffle plate.

b. Inspection.

(1) Check the pan for cracks, holes, damaged drain plug threads, and a loose baffle. Check the gasket surface for damage caused by overtorqued bolts. Straighten the surface as required to restore original flatness.

(2) Replace the pan if repairs cannot be made.

CHAPTER 7

REPAIR OF TRANSMISSION ASSEMBLY

Section I. DESCRIPTION

7-1. General

a. The transmission is a two speed unit capable of providing automatic upshifts and downshifts through the two forward gear ratios, and also capable of providing manual selection of first and second gears.

b. The transmission consists essentially of a torque converter, planetary gear train, two multiple disc clutches and a hydraulic control system. Figure 7-1 shows all the components of the transmission.

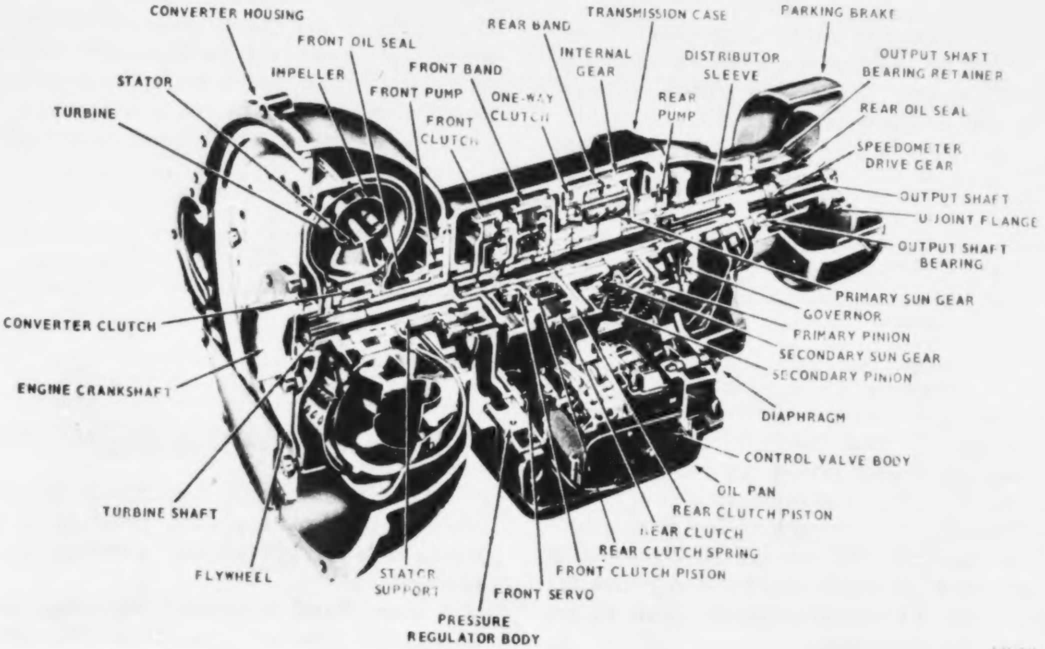

CONVERTER HOUSING
FRONT OIL SEAL
STATOR
IMPELLER
FRONT BAND
TURBINE
FRONT PUMP
FRONT CLUTCH
ONE-WAY CLUTCH
REAR BAND
INTERNAL GEAR
TRANSMISSION CASE
REAR PUMP
DISTRIBUTOR SLEEVE
PARKING BRAKE
OUTPUT SHAFT BEARING RETAINER
REAR OIL SEAL
SPEEDOMETER DRIVE GEAR
OUTPUT SHAFT
U-JOINT FLANGE
OUTPUT SHAFT BEARING
PRIMARY SUN GEAR
GOVERNOR
PRIMARY PINION
SECONDARY SUN GEAR
SECONDARY PINION
DIAPHRAGM
CONTROL VALVE BODY
OIL PAN
REAR CLUTCH PISTON
REAR CLUTCH
REAR CLUTCH SPRING
FRONT CLUTCH PISTON
FRONT SERVO
PRESSURE REGULATOR BODY
STATOR SUPPORT
FLYWHEEL
TURBINE SHAFT
ENGINE CRANKSHAFT
CONVERTER CLUTCH

Figure 7-1. Transmission Cutaway.

7-2. Operation

a. Torque Converter. The hydraulic torque converter consists of an impeller (pump), a turbine, and a stator. All these parts are enclosed and operate in a fluid-filled housing.

(1) When the engine is running, the fluid in the torque converter flows from the impeller to the turbine and back to the impeller through the stator. This flow produces a maximum torque increase of about 2 to 1 when the turbine is stalled. When enough torque is developed by the impeller, the turbine begins to rotate, turning the turbine shaft.

(2) The converter torque multiplication gradually tapers off as turbine speed approaches impeller speed, and it becomes 1 to 1 when the turbine is being driven at 9/10 impeller speed. This is known as the coupling point.

(3) When the turbine is rotating at less than 9/10 impeller speed, the converter is multiplying torque. The fluid leaving the turbine blades strikes the front face of the stator blades. These blades are held stationary by the action of a one-way clutch as long as the fluid is directed against the front face of the blades.

(4) When the turbine rotates faster than 9/10

impeller speed, the converter no longer multiplies torque. The fluid is directed against the back face of the stator blades. As the one-way clutch permits the stator to rotate only in the direction of impeller rotation, the stator begins to turn with the impeller and turbine. The converter operates as an efficient fluid coupling as long as the turbine speed remains greater than 9/10 impeller speed.

(5) A constant flow of fluid into and out of the converter is maintained. Some of the fluid coming out of the converter is forced through a cooler located in the radiator tank.

b. Planetary Gear Train. The planetary gear train consists of a primary sun gear, secondary sun gear, primary and secondary pinions which are held in a common carrier, and an internal gear to which the transmission output shaft is attached.

c. Front Clutch. The front clutch drive plates are connected to the turbine shaft through the front clutch drum. The driven plates are connected to the primary sun gear shaft.

(1) The front clutch is operated by fluid pressure against the clutch piston. The piston moves against a disc spring which acts as a lever to lock the drive and driven plates together. When the clutch is applied, the primary sun gear is locked to and driven by the turbine shaft. The piston is returned to the release position by the disc spring when the fluid pressure is removed. A check ball is installed in the front clutch piston to permit fluid exhaust, when the piston is in its released position.

(2) In neutral, the front clutch drum and steel plates are being driven while the composition plates are stationary. In reverse, the clutch is not applied, since the steel and composition plates must rotate in opposite directions. See table 7-1 for Clutch Applications.

d. Rear Clutch. The rear clutch is operated by fluid pressure against the clutch piston. Movement of the piston compresses the release spring and locks the multiple-disc clutch. The rear clutch drive plates are splined to the front clutch drum and the driven plates are connected to the rear clutch drum and secondary sun gear.

Table 7-1. Clutch Applications

Gear	Selector Lever Position	Clutch Applied	Band Applied	Gear Ratio
Neutral	N	None	None	
Low	D	Front	Front	1.47:1
High	D	Front and Rear	None	1.00:1
Reverse	R	Rear	Rear	2.00:1

(1) When the rear clutch is applied (in the reverse and third gear ratios) the secondary sun gear is driven. The piston is returned to the released position by the release spring.

(2) In neutral, the rear clutch composition plates are being driven while the steel plates are free. In second gear, the composition plates are driven, but the steel plates are held stationary. In first gear, the composition plates are driven clockwise at engine speed while the steel plates are driven counterclockwise. See table 7-1 for clutch applications.

e. Front Band and Servo. One end of the front band, which encircles the rear clutch drum, is anchored to the transmission case, and the other end is connected to the front servo.

(1) Fluid pressure moves the front servo piston against the inner end of the front servo actuating lever. Force is transmitted through a strut between the outer end of the lever and the end of the band to tighten the band around the rear clutch drum.

(2) Under certain conditions, the servo is released by directing fluid pressure to the opposite side of the piston, assisted by release spring force.

f. Rear Band and Servo. The rear band fits around the planetary gear drum. One end of the band contacts the end of the band adjusting screw, and the other end connects to the rear servo.

7-3. Hydraulic Control System

Operation of the servos and clutches is accomplished by directing hydraulic fluid under various pressures through the control valve body. The levels of these pressures are determined as outlined in the following paragraphs. Refer to figure 7-2 for a schematic of the hydraulic control system.

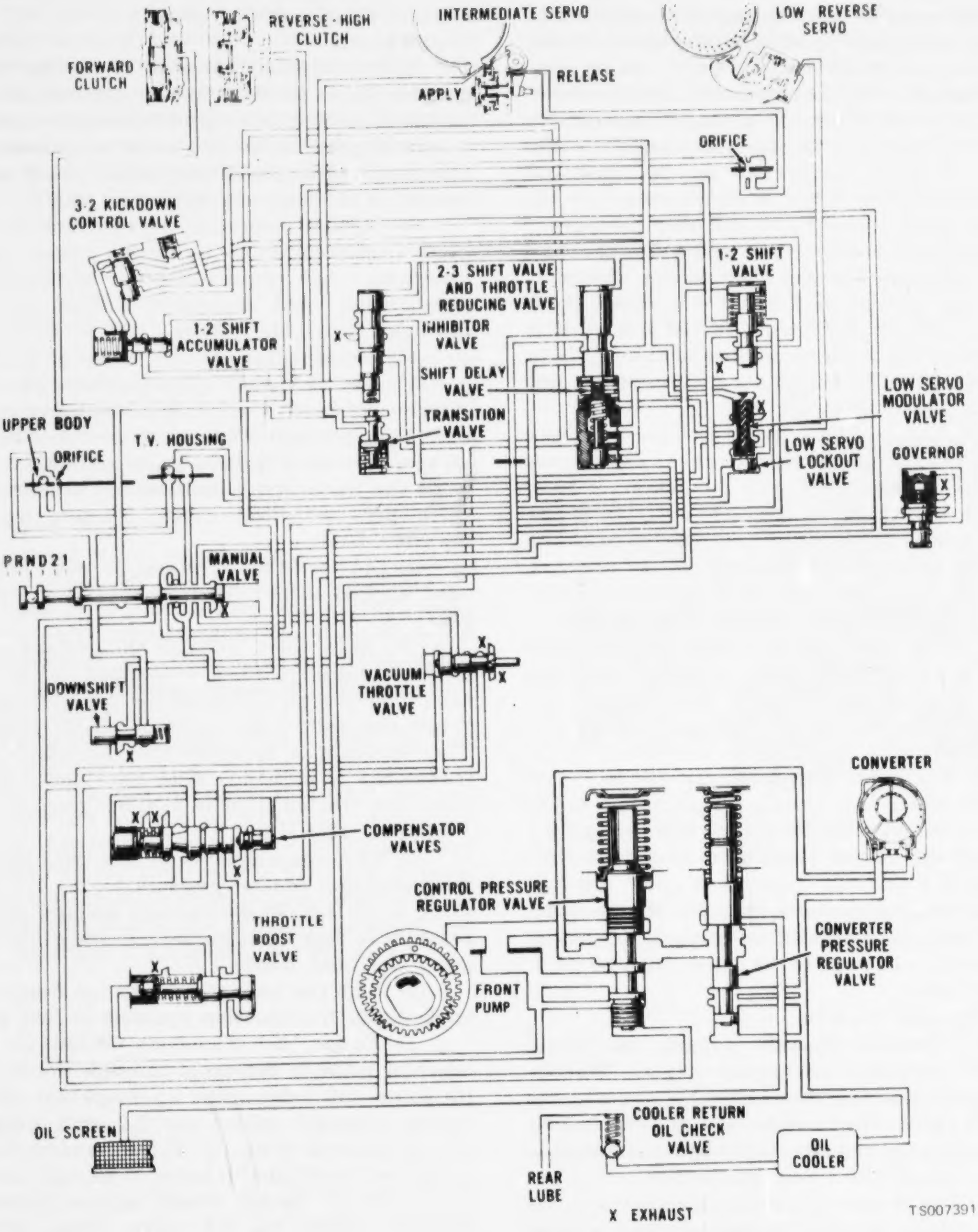

FORWARD CLUTCH
REVERSE-HIGH CLUTCH
INTERMEDIATE SERVO
APPLY
RELEASE
LOW REVERSE SERVO
ORIFICE
3-2 KICKDOWN CONTROL VALVE
1-2 SHIFT ACCUMULATOR VALVE
2-3 SHIFT VALVE AND THROTTLE REDUCING VALVE
INHIBITOR VALVE
SHIFT DELAY VALVE
TRANSITION VALVE
1-2 SHIFT VALVE
LOW SERVO MODULATOR VALVE
LOW SERVO LOCKOUT VALVE
GOVERNOR
UPPER BODY
ORIFICE
T.V. HOUSING
PRND21
MANUAL VALVE
DOWNSHIFT VALVE
VACUUM THROTTLE VALVE
COMPENSATOR VALVES
CONVERTER
CONTROL PRESSURE REGULATOR VALVE
CONVERTER PRESSURE REGULATOR VALVE
THROTTLE BOOST VALVE
FRONT PUMP
OIL SCREEN
COOLER RETURN OIL CHECK VALVE
OIL COOLER
REAR LUBE
X EXHAUST
TS007391

Figure 7-2. Hydraulic Control System.

a. Control Pressure and Compensator Pressure.

(1) Control pressure is regulated by the spring-loaded control pressure regulator valve. It is adjusted to engine torque, road speed, and selector lever position.

(2) To accomplish this, compensator pressure under various conditions is adjusted by throttle pressure (engine torque), governor pressure (road speed), or selector lever position. Compensator pressure, in turn, adjusts control pressure.

b. Converter Pressure. Like control pressure, converter pressure is regulated by the converter pressure regulator valve spring and is adjusted to driving conditions by compensator pressure and selector lever positions.

c. Manual Valve. Line pressure is delivered to the manual valve through a single passage; the valve is positioned in the valve body by the manual linkage, according to the mode of operation desired. Fluid is distributed from the manual valve through the following passages.

(1) *The D passage—charged in D range only.* The D passage supplies fluid to the downshift valve, and through the 1-2 shift shuttle ball check valve to the 1-2 shift valve. In addition, fluid is directed to the 2-3 shift orifice and through it to the 2-3 shift valve and to the bottom of the rear servo lockout valve.

(2) *The D-2-1 passage—charged in Drive range, manual Second gear (2 range) and manual low gear (1 range).* The D-2-1 passage directs apply fluid to the forward clutch, applying it, and to the upper end of the transition valve, to the governor valve and to the compensator cut back valve.

(3) *The 2-1-R-P passages—charged in 2, 1 and Reverse.* The 2-1-R-P passage supplies fluid to the upper valley of the 1-2 shift valve, and passes through the 1-2 shift valve bore to the adjacent ends of the 1-2 shift accumulator and lockout valves.

(4) *The 1-R-P passages—charged in 1, and Reverse.* The 1-R-P passage supplies fluid to the valley of the 2-1 scheduling valve and through the 1-2 shift shuttle ball check valve to the 1-2 shift valve.

(5) *The R Passage—charged in R range only.* The R passage supplies fluid to the left valley of the throttle valve and to the upper valley of the 2-3 shift valve.

d. Throttle Pressure.

(1) Throttle pressure adjusts the transmission operation to engine torque. Throttle pressure is produced from control pressure by the throttle valve. The throttle valve is controlled by a spring-loaded vacuum diaphragm unit mounted on the rear of the transmission case.

(2) The vacuum diaphragm is actuated by the engine intake manifold vacuum working against spring pressure. When the vacuum is higher than 16 inches, the diaphragm moves against spring pressure and moves the pushrod away from the throttle valve to cut off the throttle pressure regulation. As the engine throttle is advanced, manifold vacuum will fall below 16 inches. As the vacuum drops, the spring-loaded diaphragm moves the pushrod to open the throttle valve and increase the throttle pressure.

e. Neutral.

(1) The manual valve at N selector lever position blocks the fluid flow to both clutches and both bands. With no fluid pressure in the clutches or servos, the clutches and bands are released by spring pressure, preventing power being transmitted to the transmission output shaft.

(2) Neutral operation of the transmission keeps control pressure up to its proper value, maintains a full torque converter, lubricates the transmission, and maintains a flow of fluid through the cooling system.

f. D, Low Gear.

(1) The 1-2 shift occurs when governor pressure force on the 1-2 shift valve overcomes shift plug pressure and spring forces. The 1-2 valve moves inward, exhausting the fluid which holds the transition valve closed. The transition valve opens and admits control pressure to apply the front band.

(2) The front clutch remains on, and the front band applied to put the transmission in second gear.

g. D, High Gear. The 2-3 shift occurs when governor pressure force overcomes spring and shift plug pressure force at the 2-3 shift valve. When the shift valve opens, control pressure flows through it to apply the rear clutch and release the front band. With both clutches applied, the transmission is in third gear.

h. Low Gear.

(1) When the manual valve is at the 2 selector lever position, control pressure to the 1-2 shift valve is cut off. This condition permits control pressure to flow through the transition valve to apply the front band.

(2) With the front clutch and the front band applied, the transmission operates in first gear.

i. D Range, 2-1 Kickdown. When the accelerator pedal is depressed through the detent, the down-shift valve opens a passage that admits control pressure behind the 1-2 shift plug to oppose governor pressure. If the transmission is in high and road speed is below 47-69 mph, the 2-3 valve will be forced closed against governor pressure. When the 2-3 valve closes, control pressure which has been applying the rear clutch and releasing the front band is exhausted. The apply pressure that was in the front servo in third gear is now free to apply the front band. As soon as the front band applies, the transmission is in second gear.

j. Reverse. When the manual valve is shifted into reverse, control pressure is directed to apply the rear clutch and rear band. Governor supply pressure is cut off by the manual valve; hence, the transmission cannot shift automatically. Rear clutch pressure is also directed to the throttle valve to regular throttle pressure to obtain the correct line pressure for the reverse circuit.

k. Fluid Cooling and Lubricating System.

(1) The converter out circuit is directed through the oil cooler, then the cooled fluid is used in the transmission lubricating circuit.

(2) A spring-loaded check valve is used in the circuit to maintain about 3-5 PSI in the converter out circuit. When the converter out circuit exceeds 3-5 PSI, the check ball opens against spring pressure and cooled fluid is directed to lubricate the various parts of the transmission gear train.

Section II. ADJUSTMENTS AND TESTS

7-4. General

Prior to removal of the transmission from the vehicle for disassembly or repair, make certain that a band adjustment as outlined below is not the cause of malfunction. The tests outlined in the following paragraphs will aid in determining the exact cause of the malfunction.

7-5. Band Adjustments

a. Front Band Adjustment.

(1) Drain the fluid from the transmission. If the same fluid is to be used again in the transmission after the band adjustment, filter the fluid through a 100-mesh screen as it drains from the transmission. Reuse the fluid only if it is in good condition.

(2) Remove the pan, then remove the fluid filter and clip from the transmission. Clean the inside of the pan. Remove all gasket material from the pan and pan mounting face of the case.

(3) Loosen the front servo adjusting screw locknut two full turns with a 9/16 inch wrench. Check the adjusting screw for free rotation in the actuating lever after the locknut is loosened, and free the screw if necessary. See figure 7-3.

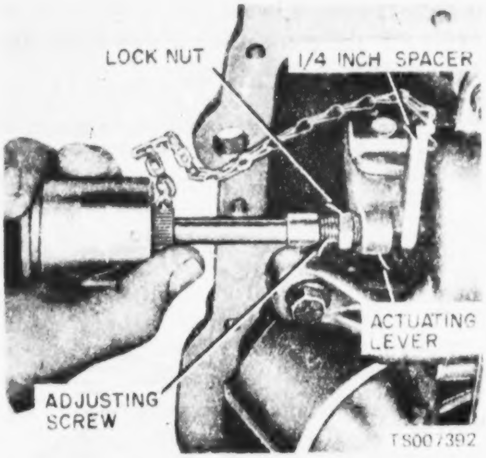


Figure 7-3. Front Band Adjustment.

(4) Pull the adjusting screw end of the actuating lever away from the servo body, and insert the ¼ inch spacer between the servo piston stem and the adjusting screw.

(5) Install the socket handle on the 9/16 inch socket.

(6) Insert the T-handle extension through the socket handle and socket, and install the screwdriver socket on the T-handle extension.

(7) Place the tool on the adjusting screw so that the screwdriver socket engages the screw and the 9/16 inch socket engages the locknut.

(8) With a torque wrench on the T-handle extension, tighten the adjusting screw to 10 in./lbs torque.

(9) Remove the spacer and tighten the adjusting screw an additional ¾ turn. Hold the adjusting screw stationary, and torque the locknut to specification.

(10) Place a new gasket on the pan, and install the screen and pan on the transmission.

(11) Fill the transmission with fluid. See LO 10-3930-633-12.

b. Rear Band Adjustment.

(1) Remove all dirt from adjusting screw and surrounding area. See figure 7-4.

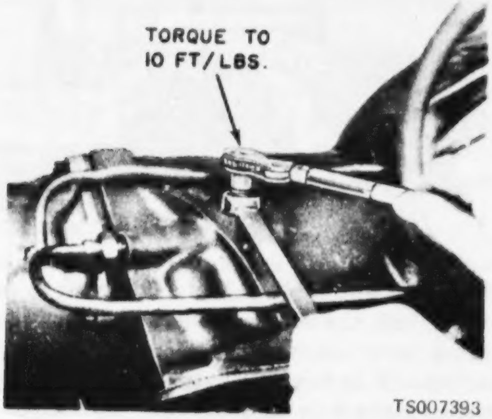


Figure 7-4. Rear Band Adjustment.

(2) Loosen the adjusting screw locknut with a box end wrench as shown in the illustration.

(3) Using a torque wrench, tighten the adjusting screw to 10 ft/lbs. Try to get the adjustment as close to exactly 10 ft/lbs as possible.

(4) If the screw is found to be tighter than wrench capacity (10 ft/lbs torque), loosen the screw and tighten until the wrench clicks and breaks.

(5) Back off the adjusting screw 1-½ turns. Hold the adjusting screw stationary and tighten the adjusting screw locknut to specification. Severe damage may result if the adjusting screw is not backed off exactly 1½ turns.

7-6. Stall Test

a. Start the engine to allow it to reach its normal temperature. Apply both the parking and service brakes while making tests.

b. The stall test is made in D, or R, at full throttle to check engine performance, converter clutch operation or installation, and the holiday ability of the forward clutch, reverse-high clutch and low-reverse band and the gear train one-way clutch. While making this test, do not hold the throttle open for more than five seconds at a time. Then move the selector lever to Neutral and run engine at 1000 RPM for about 15 seconds to cool the converter before making the next test. If the engine speed recorded by the tachometer exceeds the maximum limits, 1300 to 1500 RPM, release the accelerator immediately because clutch or band slippage is indicated.

7-7. Control Pressure Checks

a. When performing control pressure checks, make certain that the engine is at normal operating temperature and that timing and carburetor are properly adjusted. Set parking brake firmly to prevent vehicle motion. Check manifold vacuum (see Chapter 6) to make certain a reading of 18 inches (Hg) is obtained at engine idle. At higher altitudes, it may not be possible to obtain 18 inches of vacuum; under these conditions, use the chart in the lower part of table 7-2 to adjust pressure readings in proportion to the lower vacuum readings. Make certain, however, that the lower vacuum reading is not due to a leak in the transmission or distributor vacuum line.

b. With vacuum readings and engine adjustments verified, connect a pressure gage of 0-250 PSI range to the control pressure port shown in figure 7-5, and proceed with test as follows:

Table 7-2. Control Pressure Checks

Engine Speed	Throttle	Manifold Vac Ins Hg	Range	P S I
Idle	Closed	Above 18[1]	P. N. D.	57-77
			R	64-105
As Required	As Required	10	D	82-111
As Required	As Required	Below 1.0	D	146-175
			R	201-213

[1] At altitudes above sea level it may not be possible to obtain 18 inches of engine vacuum at idle. For idle vacuums of less than 18 inches refer to the following table to determine idle speed pressure specification in D driving range.

Engine Vacuum	Line Pressure
17 inches	57-77
16 inches	57-82
15 inches	57-88
14 inches	57-95
13 inches	57-102
12 inches	57-108
11 inches	57-115

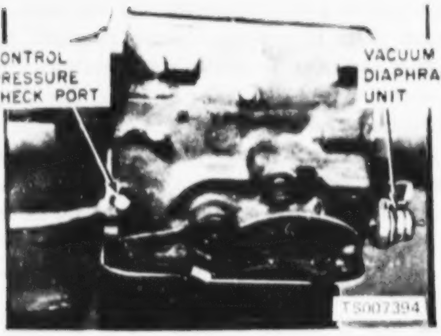


Figure 7-5. Control Pressure Port.

(1) At engine idle check control pressure readings in all selector lever positions.

(2) Advance throttle to obtain 10 inches of vacuum, and check pressure readings in all selector lever positions.

(3) Advance throttle to obtain 1.0 inches or less, and check pressure readings in all selector lever positions.

(4) Compare readings with those given in table 7-2. If vacuum and pressure readings are within specifications, the diaphragm unit and control pressure regulating system are operating properly. If control pressures are not within specifications, refer to table 7-3 for causes of abnormal reading.

Table 7-3. Abnormal Pressure Reading Diagnosis

Engine Vacuum Reading (In. / Hg)	Control Pressure Level	Possible Causes
18	Low	Front oil pump leakage Control valve leakage Control pressure regulator sticking
	High	Defective diaphragm unit
10 and 1.0 or less	High or Low	Internal leakage Low pump capacity (wear) Restricted oil pan screen Defective diaphragm unit

7-8. Air Pressure Checks

A "NO DRIVE" condition can exist, even with correct fluid control pressure, because of inoperative clutches or bands. Erratic shifts could be caused by a stuck governor valve. The inoperative units can be located through a series of checks by substituting air pressure for the fluid pressure to determine the location of the malfunction.

a. Clutch Failures. When the selector lever is at 2, a NO DRIVE condition may be caused by an inoperative forward clutch. A NO DRIVE condition at D may be caused by an inoperative forward clutch or one-way clutch. When there is NO DRIVE in 1, the difficulty could be caused by improper functioning of the forward clutch or low-reverse band and the one-way clutch. Failure to drive in reverse range could be caused by a malfunction of the reverse-high clutch or low-reverse band.

b. Test Set-up. To make the air pressure checks, loosen the oil pan bolts and lower one edge of the oil pan to drain the transmission fluid. Remove the pan and the control valve body assembly. The inoperative units can be located by introducing air pressure into the transmission case passages leading to the clutches, servos, and governor (fig. 7-6). 50-75 PSI pressure is sufficient for purposes of this test.

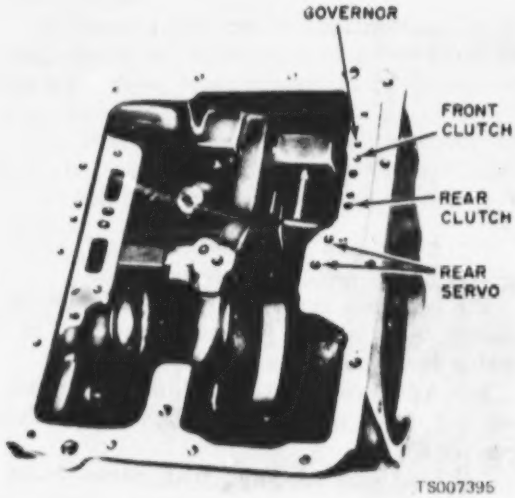


Figure 7-6. Air Pressure Checks.

c. Front Clutch. Apply air pressure to the transmission case forward clutch or front clutch passage. A dull thud can be heard when the clutch piston is applied. If no noise is heard, place the fingertips on the input shell or clutch cylinder, and again apply air pressure to the forward or front clutch passage. Movement of the piston can be felt as the clutch is applied.

d. Rear Clutch. Apply air pressure to the rear clutch passage. A dull thud indicates that the reverse-high or rear clutch piston has moved to the applied position. If no noise is heard, place the fingertips on the clutch drum and again apply air pressure to detect movement of the piston.

e. Governor. Remove the governor inspection cover from the extension housing. Apply air pressure to the front clutch passage. Listen for a sharp click, and watch to see if the governor weight snaps inward. Inward weight movement indicates correct governor valve operation.

f. Rear Servo. Apply pressure to the rear servo apply passage. Movement of the servo indicates correct operation. If servo does not operate, remove, disassemble and repair.

g. Test Results. If air pressure applied to either of the clutch passages fails to operate a clutch or operates both clutches at once, remove and, with air pressure, check the fluid passages in the case and front pump to detect obstructions.

7-9. Leakage Checks

a. Check the governor inspection plate on the extension housing for leakage. Replace gasket if leakage is apparent.

b. Leakage at the oil pan gasket often can be stopped by tightening the attaching bolts to the proper torque. If necessary, replace the gasket.

c. Check the fluid filler tube connection at the transmission case or pan. If leakage is found here, install a new O-ring or tighten the fitting to the specified torque.

d. Check the fluid lines and fittings between the transmission and the cooler in the radiator tank for looseness, wear, or damage. If leakage cannot be stopped by tightening a fitting, replace the damaged parts.

e. Check the engine coolant in the radiator. If transmission fluid is present in the coolant, the cooler in the radiator is probably leaking.

f. The cooler can be further checked for leaks by disconnecting the lines from the cooler fittings and applying 50-75 PSI air pressure to the fittings. Remove the radiator cap to relieve the pressure build-up at the exterior of the oil cooler tank. If the cooler is leaking and will not hold pressure, the radiator must be replaced. See TM 10-3930-633-12.

g. If leakage is found at either the downshift control lever shaft or the manual lever shaft, replace either or both seals.

h. Inspect the pipe plug on the left side of the transmission case at the front. If the plug shows leakage, torque the plug to specifications. If tightening does not stop the leaks, replace the plug.

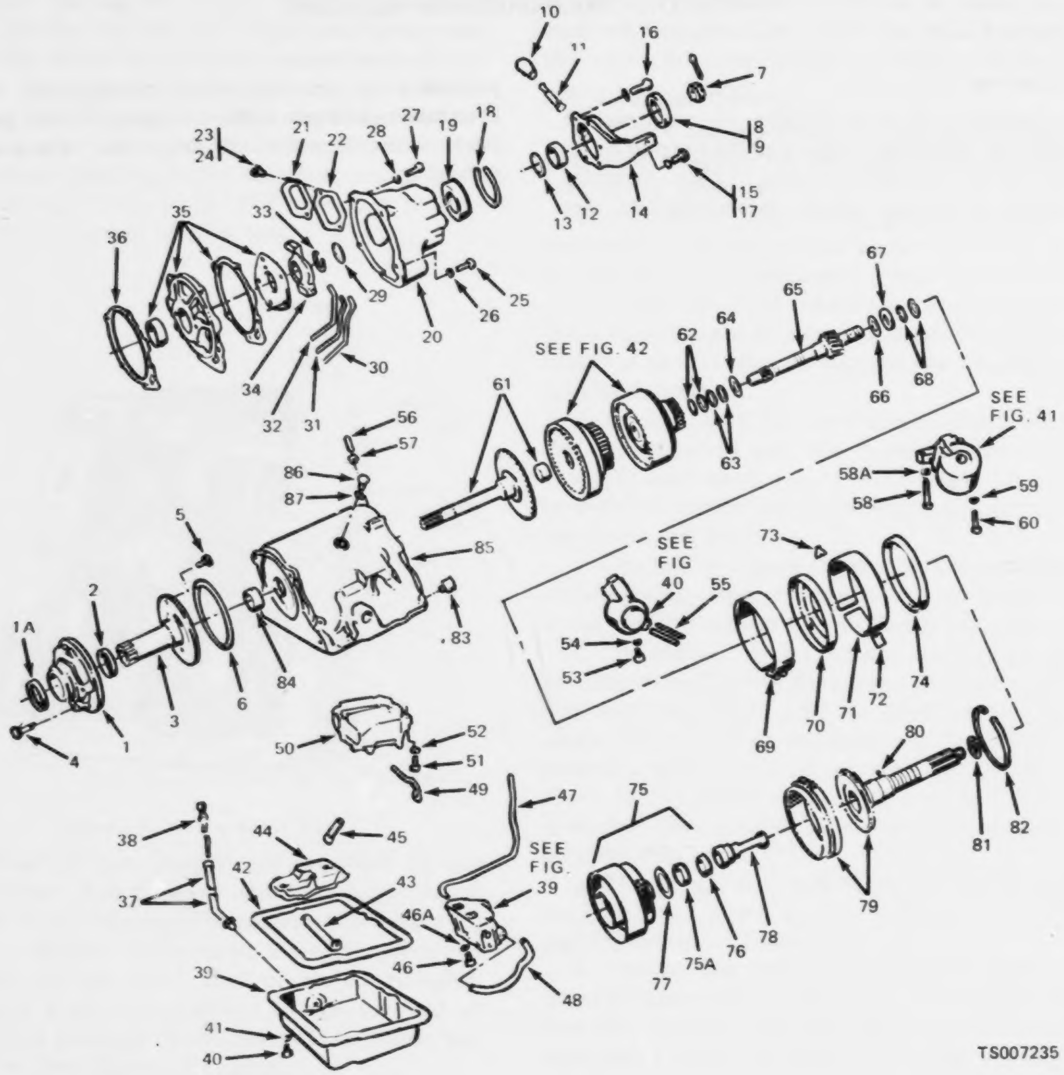
i. When a converter drain plug leaks, remove the drain plug with a six-point wrench. Coat the threads with oil-resistant sealer and install the plug. Torque the drain plug to specification. Fluid leakage from the converter housing may be caused by engine oil leaking past the rear main bearing or from oil gallery plugs. Be sure to determine the exact cause of the leak before repair procedures are started.

j. Oil-soluble aniline or fluorescent dyes premixed at the rate of ½ teaspoon of dye powder to ½ pint of transmission fluid have proved helpful in locating the source of the fluid leakage. Such dyes may be used to determine whether an engine oil or transmission fluid leak is present or if the fluid in the oil cooler leaks into the engine coolant system. A black light, however, must be used with the fluorescent dye solution.

Section III. TRANSMISSION REPAIRS

7-10. General

Transmission repairs involve the systematic disassembly, cleaning, inspection and repair of all transmission subassemblies. The specific procedures covering these subassemblies are provided in the following paragraphs, under separate headings. Refer to figure 7-7 for general parts identification during the disassembly procedure.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SEE FIG. 39
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TS007235

1. Converter pump
1A. Front seal
2. Bushing
3. Stator support
4. Capscrew
5. Capscrew
6. Charger pump gasket
7. Flange nut
8. Retaining ring
9. Out shaft seal
10. Gear bearing
11. Driven gear
12. Drive gear
13. Gear spacer
14. Bearing retainer
15. Capscrew
16. Capscrew
17. Lockwasher
18. Retaining ring
19. Out shaft bearing
20. Rear housing
21. Inspection cover
22. Cover gasket
23. Machine screw
24. Plain washer
25. Capscrew
26. Lockwasher
27. Capscrew
28. Lockwasher
29. Bearing washer
30. Rear tube
31. Intermediate tube
32. Front tube
33. Retaining ring
34. Governor assembly
35. Pump assembly
35A. Mounting gasket
36. Pump gasket
37. Oil filler tube
38. Oil level dipstick
39. Bottom pan
40. Capscrew
41. Lockwasher
42. Cover gasket
43. Sump strainer clip
44. Sump strainer
45. Pump out tube
46. Screw
46A. Lockwasher
47. Lubrication tube
48. Control pressure tube
49. Compensator pressure tube
50. Selector valve
51. Capscrew
52. Lockwasher
53. Capscrew
54. Lockwasher
55. Actuator tube
56. Capscrew
57. Hex nut
58. Capscrew
59. Capscrew
60. Lockwasher
61. Input shaft
62. Seal
63. Seal
64. Thrust washer
65. Drive shaft
66. Thrust race
67. Plain washer
68. Seal
69. Band assembly
70. Center support
71. Band assembly
72. Strut
73. Strut
74. Clutch assembly
75. Gear assembly
75A. Front bushing
76. Drum bushing
77. Washer
78. Oil sleeve
79. Drive shaft
80. Governor ball
81. Sleeve ring
82. Ring set
83. Check valve
84. Shaft bushing
85. Transmission case
86. Case bolt
87. Lockwasher

Figure 7-7. Transmission Assembly.

7-11. Torque Converter

a. General. The torque converter is mounted on the input end of the transmission and consists of an impeller, stator turbine and converter clutch.

b. Removal. The torque converter and transmission are separated upon removal of the transmission from the engine. Refer to Chapter 2, Section IV. The torque converter can be simply lifted from the converter housing upon removal of the housing from the engine. The torque converter is not repairable and must be replaced complete.

c. Cleaning. When internal wear or damage has occurred in the transmission, metal particles, clutch plate or band material may have been carried into the converter. These contaminants are a major cause of recurring transmission troubles and MUST be removed from the system before the transmission is put back into service. The converter must be cleaned by using a mechanically agitated cleaner.

d. Stator to Impeller Interference Check.

(1) Position the front pump assembly on a bench with the spline end of the stator shaft pointing up.

(2) Mount a converter on the pump so that the splines on the one-way clutch inner race. engage the mating splines of the stator support, and the converter hub engages the pump drive gear.

(3) While holding the pump stationary, try to rotate the converter counterclockwise. The converter should rotate freely without any signs of interference or scraping within the converter assembly.

(4) If there is an indication of scraping, the trailing edges of the stator blades may be interfering with the leading edges of the impeller blades. In such cases, replace the converter.

(5) If interference exists, the stator front thrust washer may be worn, allowing the stator to hit the turbine. In such cases, the converter must be replaced.

(6) The converter crankshaft pilot should be checked for nicks or damaged surfaces that could cause interference when installing the converter into the crankshaft. Check the converter front pump drive hub for nicks or sharp edges that would damage the pump seal.

e. Stator to Turbine Interference Check.

(1) Position the converter on the bench front side down.

(2) Install a front pump assembly to engage the mating splines of the stator support and stator, and pump drive gear lugs.

(3) Install the input shaft, engaging the splines with the turbine hub.

(4) While holding the pump stationary, attempt to rotate the turbine withthe input shaft. The turbine should rotate freely inboth directions without any signs of interference or scraping noise.

f. Installation.

(1) Carefully position the converter and housing to the transmission making sure the converter drive flats are fully engaged in the pump gear. Install a wedge to prevent the converter from slipping out of the housing.

(2) Refer to Chapter 2, Section IV for transmission assembly installation.

7-12. Transmission Disassembly and Reassembly

a. Disassembly.

(1) Before removing any of the transmission subassemblies, thoroughly clean the outside of the transmission case to prevent dirt from getting inside the mechanism.

(2) After the transmission has been removed from the vehicle, disconnect the oil cooler line at the transmission. Place the unit in a work stand or on a clean bench.

(3) Remove the transmission pan, gasket, and screen retainer clip.

(4) Lift the screen from the case.

(5) Remove the spring seat from the pressure regulator. Maintain constant pressure on the seat to prevent distortion of the spring seat and the sudden release of the springs. Remove the pressure regulator springs and pilots, but do not remove valves.

(6) Remove the small compensator pressure tube from the pressure regulator and the control valve body.

(7) Remove the main pressure oil tube first, by gently prying up the end that connects to the main control valve assembly, then, remove the other end of the tube from the pressure regulator. Be sure to remove the tube in this manner. Failure to do so could kink or bend the tube causing excessive transmission internal leakage.

(8) Loosen the front and rear servo band adjusting screws five turns. Loosen the front servo attaching bolts three turns.

(9) Remove the vacuum diaphragm unit and pushrod.

(10) Remove the control valve body attaching bolts. Align the levers to permit removal of the valve body. Then lift the valve body clear of the transmission case. Pull the body off the servo tubes and remove it from the case.

(11) Remove the regulator from the case. Keep the control pressure valve and the converter pressure regulator valve in the pressure regulator to avoid damage to the valves.

(12) Remove the front servo, apply and release tubes by twisting and pulling at the same time. Remove the front servo attaching bolts. Hold the front servo strut with the fingers, and lift the servo assembly from the case.

(13) Remove the rear servo attaching bolts. Hold the actuating and anchor struts with the fingers, and lift the servo from the case.

b. Transmission End Play Check.

(1) Remove one of the front pump attaching bolts. Mount a dial indicator support in the front pump bolt hole. Mount a dial indicator on the support so that the contact rests on the end of the turbine shaft.

(2) Pry the output shaft all the way forward by using a screwdriver between the large internal gear and the case.

(3) Lightly block the output shaft in the forward position to eliminate all output shaft end play.

(4) Move the pinion carrier all the way forward by inserting a screwdriver between the planet carrier and the large internal gear and prying against the case. Maintain slight forward pressure, and set the dial indicator at zero.

(5) Measure and record the end play between the front of the case and the large internal gear by prying between the front clutch cylinder and the case. This end play should be 0.010–0.029 inch. Total end play including output shaft end play must not exceed 0.044 inch.

c. Removal of Case and Extension Housing Parts.

(1) Remove the remaining front pump attaching bolts. Then remove the front pump and gasket. (If necessary, tap the screw bosses with a soft-faced hammer to loosen the pump from the case.) Remove the parking brake drum and spline flange. See figure 7-8.

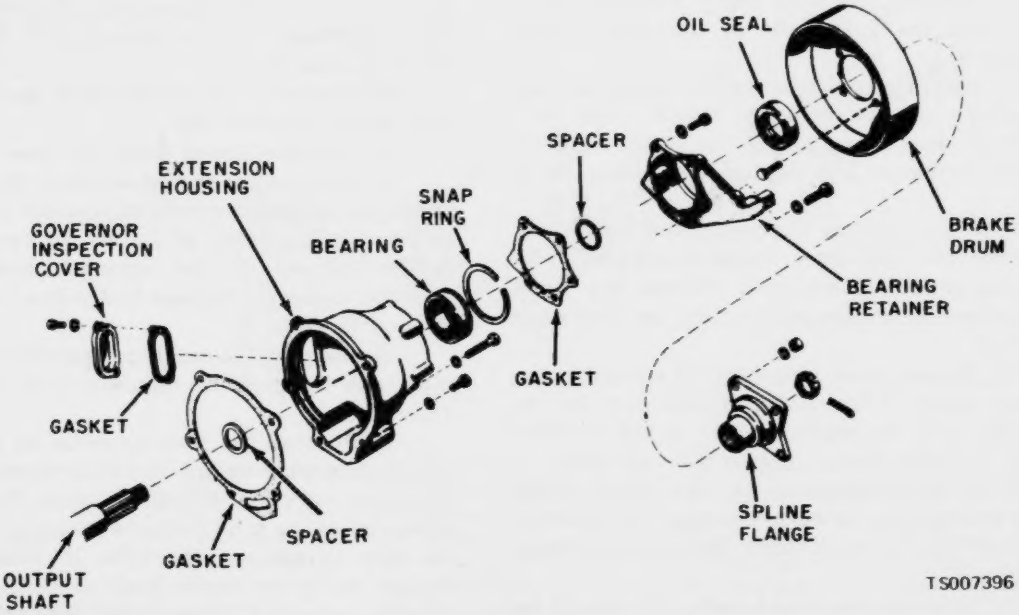


Figure 7-8. Extension Housing Parts.

(2) Remove the extension housing seal. Remove the lubrication tube from the case. Remove the five transmission to extension housing bolts. These bolts also attach the rear support to the case. Remove the extension housing.

(3) Remove the output shaft assembly (fig. 7-9). Be careful not to bend the pressure tubes between the distributor sleeve and case as the tubes are removed from the case.

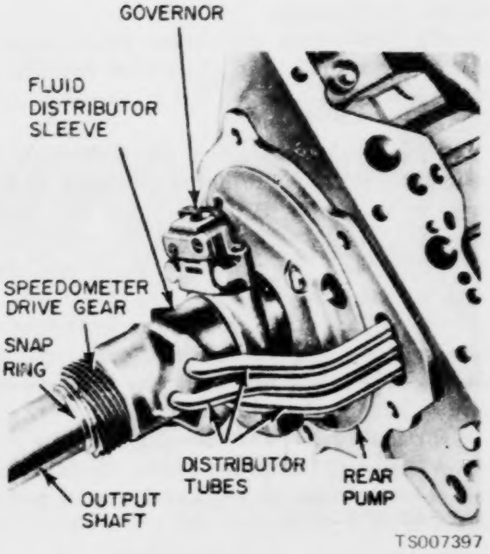

GOVERNOR
FLUID DISTRIBUTOR SLEEVE
SPEEDOMETER DRIVE GEAR
SNAP RING
DISTRIBUTOR TUBES
REAR PUMP
OUTPUT SHAFT
TS007397

Figure 7-9. Output Shaft and Rear Pump.

(4) Place the output shaft assembly on the bench and remove the oil distributor tubes from the sleeve.

(5) Slide the speedometer drive gear off the shaft.

(6) If the drive gear ball does not fall out as the speedometer gear is removed, remove the ball from the seat in the output shaft.

(7) Remove the distributor sleeve. Remove the four seal rings from the output shaft with the fingers to prevent breaking the rings.

(8) Remove the governor snap ring from the output shaft. Slide the governor assembly off the output shaft. Then remove the governor drive ball. Remove the rear pump, extension housing and pump gaskets.

(9) Remove the rear pump drive key from the output shaft. Then remove the bronze thrust washer from the output shaft.

(10) Remove the selective thrust washer from the rear of the pinion carrier.

(11) Remove the two seal rings from the primary sun gear shaft. Remove the pinion carrier.

(12) Remove the primary sun gear rear thrust bearing and race from the pinion carrier.

(13) Note the rear band position for reference in assembly. The end of the band next to the adjusting screw has a depression (dimple) in the center of the boss. Squeeze the ends of the rear band together, tilt the band to the rear, and remove the rear band from the case.

(14) Remove the two center support outer bolts (one each side) from the transmission case

(15) Exert enough pressure on the end of the input shaft to hold the clutch units together. Then remove the center support and the front and rear clutch assemblies as a unit (fig. 7-10).

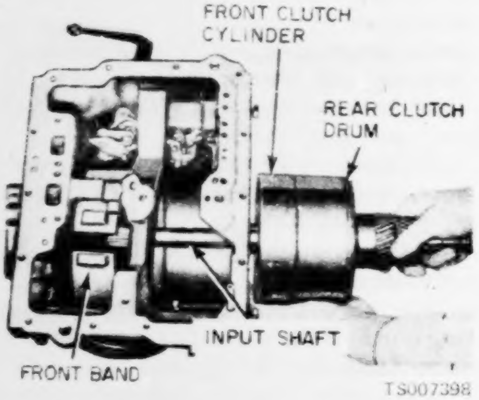

FRONT CLUTCH CYLINDER
REAR CLUTCH DRUM
INPUT SHAFT
FRONT BAND
TS007398

Figure 7-10. Input Shaft and Clutch.

(16) Set the clutch assemblies up on the sun gear end as shown in figure 7-11.

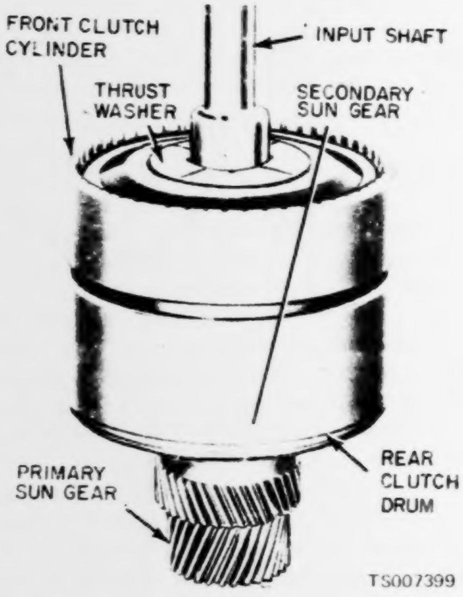

FRONT CLUTCH CYLINDER
INPUT SHAFT
THRUST WASHER
SECONDARY SUN GEAR
PRIMARY SUN GEAR
REAR CLUTCH DRUM
TS007399

Figure 7-11. Input Shaft and Clutch Removal.

(17) Remove the thrust washer from the front of the input shaft.

(18) To remove the front band, position the

band ends between the case webbing and tilt the bottom of the band rearward. Then, squeeze the ends of the band together and remove from the rear of the case.

(19) Lift the front clutch assembly from the primary sun gear shaft.

(20) Remove the bronze and the steel thrust washers from the rear clutch assembly; wire the thrust washers together to assure correct installation.

(21) Remove the front clutch seal rings from the primary sun gear shaft.

(22) Lift the rear clutch assembly from the primary sun gear shaft.

(23) Remove the rear clutch seal rings from the primary sun gear shaft. Do not break the seal rings.

(24) Remove the primary sun gear front thrust washer.

d. Assembly. Do not use force to assemble mating parts. If the parts do not assemble freely, examine them for the cause of the difficulty. Always use new gaskets and seals during the assembly operation.

(1) Install the front band in the transmission case so that the anchor end is aligned with the anchor in the case.

(2) Make sure the thrust washer is in place on the input shaft. Lift the clutch assemblies out of the holding block. Do not allow the clutches to separate.

(3) Install the clutch subassemblies in the transmission case while positioning the servo band on the drum. Hold the units together while installing them (fig. 7-10).

(4) Install the center support and the rear band in the case.

(5) Install the primary sun gear rear thrust bearing race, needle bearing, and front thrust bearing race in the planet carrier using petroleum jelly to retain them in place.

(6) Lubricate the bearing surface on the center support, the rollers of the planetary clutch, and the cam race in the carrier with petroleum jelly (fig. 7-12).

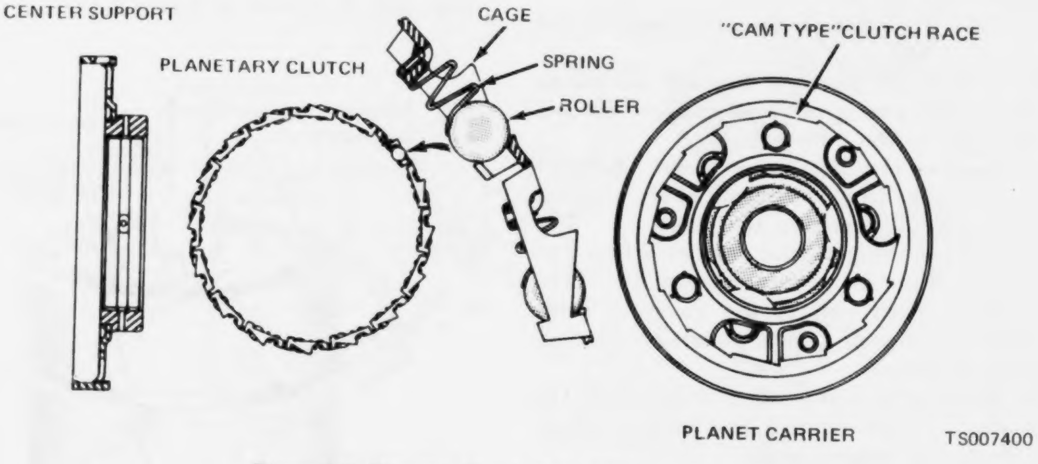


Figure 7-12. Planetary Clutch, Carrier and Center Support.

(7) Install the planetary clutch in the carrier (fig. 7-13).

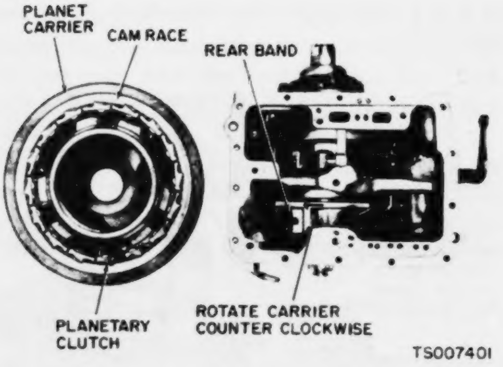


Figure 7-13. Planetary Clutch Installation.

(8) Carefully position the planet carrier on the center support. Move the carrier forward until the clutch rollers are felt to contact the bearing surface of the center support.

(9) While applying forward pressure on the planet carrier, rotate it counterclockwise, as viewed from the rear (fig. 7-13). This will cause the clutch rollers to roll toward the large opening end of the cams in the race, compressing the spring slightly, so that the rollers will ride up the chamfer on the planetary support and onto the inner race.

(10) Push the planet carrier all the way forward.

(11) Check the operation of the planetary clutch by rotating the carrier counterclockwise. It should rotate counterclockwise (viewed from the rear) with a slight drag, and it should lock up when attempting to rotate it in a clockwise direction.

(12) Install the selective thrust washer on the pinion carrier rear pilot. If the end play was not within specifications when checked prior to disassembly, replace the washer with one of proper thickness. Refer to TM 10-3930-633-34P for selective thrust washer thicknesses.

(13) Install the output shaft, carefully meshing the internal gear with the pinions.

(14) With the center support properly assembled, position the rear pump drive key in the keyway on the output shaft.

(15) Position new front and rear gaskets on the pump body. Retain the gaskets with transmission fluid. Then install the rear pump. Be sure the drive key is aligned with the keyway in the pump drive gear.

(16) Position the governor drive ball in the pocket in the output shaft. Retain the ball with transmission fluid.

(17) Install the governor assembly, aligning the groove with the ball in the output shaft.

(18) Install the governor with the governor body plate toward the rear of the transmission. Install the governor snap ring.

(19) Place the four seal rings in the distributor sleeve, and check the ring gap.

(20) Check the fit of the seal rings in the grooves in the output shaft. The rings should rotate freely. Install the rings in the grooves of the output shaft.

(21) Install the three tubes in the distributor sleeve.

(22) Install the distributor sleeve on the output shaft, with the chamfer facing forward. Lubricate the parts to facilitate assembly. Slide the sleeve over the four rings and at the same time start the tubes into the case. The distributor sleeve is located between the governor snap ring and speedometer drive gear.

(23) Make sure that the speedometer drive gear lock ball is in place, then install the gear.

(24) Install the output shaft ball bearing front spacer and the output shaft ball bearing with the snap ring toward the rear.

(25) Install the output shaft rear spacer and the speedometer drive gear.

(26) Install the rear bearing retainer gasket and the retainer. Torque the bolts to specifications.

(27) Install the brake drum and companion flange. Torque the nut to 150—200 ft/lb. Tighten the nut to the nearest cotter pin hole, and install the cotter pin.

(28) Position a new front pump gasket in the counterbore of the transmission case.

(29) Install the front pump, aligning the pump bolt holes with the holes in the case. Install three of the front pump attaching bolts and torque them to 17—22 ft/lb.

(30) Mount dial indicator support in a front pump bolt hole. Mount a dial indicator on the support so that the contact rests on the end of turbine shaft.

(31) Pry the output shaft all the way forward by using a screwdriver between the large internal gear and the case.

(32) Lightly block the output shaft in the forward position to eliminate all output shaft end play.

(33) Move the pinion carrier all the way forward by inserting a screwdriver between the planet carrier and the large internal gear and prying against the case. Maintain slight forward pressure, and set the dial indicator at zero.

(34) Measure and record the end play between the front of the case and the large internal gear by prying between the front clutch cylinder and the case. This end play should be 0.010—0.029 inch. Total end play including the output shaft, must not exceed 0.044 inch.

(35) Remove the dial indicator and install the fourth pump mounting bolt. Torque all four bolts to 17—22 ft/lb.

(36) Position the front band forward in the case with the band ends up.

(37) Position the servo strut with the slotted end aligned with the servo actuating lever, and the small end aligned with the band end. Rotate the band, strut, and servo into position engaging the anchor end of the band with the anchor pin in the case.

(38) Locate the servo on the case, and install the attaching bolts. Tighten the attaching bolts only 2 or 3 threads.

(39) Install the servo tubes.

(40) Position the servo anchor strut, and rotate the rear band to engage the strut.

(41) Position the servo actuating lever strut with a finger, and then install the servo and attaching bolts. Move the servo (with reasonable force) toward the centerline of the case, against the attaching bolts. While holding the servo in this position, torque the attaching bolts to 30—35 ft/lb.

(42) Install the pressure regulator body and attaching bolts, and torque the bolts to 17—22 ft/lb.

(43) Install the control and converter valve guides and springs. Install the spring retainer.

(44) Install the control valve assembly, carefully aligning the servo tubes with the control valve. Align the inner downshift lever between the stop and the downshift valve. Shift the manual lever to the 1 position. Align the manual valve with the actuating pin on the manual detent lever. Do not tighten the attaching bolts.

(45) Install the main pressure oil tube. Be sure to install the end of the tube that connects to the pressure regulator assembly first. Then, install the other end of the tube into the main control assembly by tapping it gently with a soft hammer.

(46) Install the small control pressure compensator tube in the valve body and regulator.

(47) Move the control valve body toward the center of the case until the clearance is less than 0.050 inch between the manual valve and the actuating pin on the manual detent lever.

(48) Torque the attaching bolts to 8 - 10 ft/lb. Be sure that the rear fluid screen retaining clip is installed under the valve body as shown in figure 7-14.

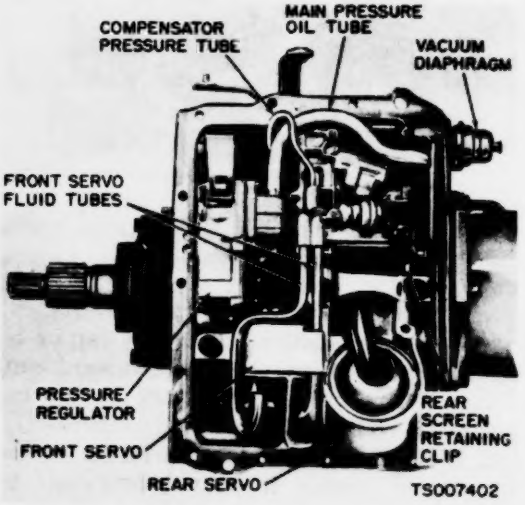


Figure 7-14. Control Valve Body Installed.

(49) Turn the manual valve one full turn in each manual lever detent position. If the manual valve binds against the actuating pin in any detent position, loosen the valve body attaching bolts and move the body away from the center of the case. Move the body only enough to relieve the binding. Torque the attaching bolts and check the manual valve for binding.

(50) Torque the front servo attaching bolts to 30 - 35 ft/lb.

(51) Adjust the front and rear bands as detailed in paragraph 7-5.

(52) Position the control rod in the bore of the vacuum diaphragm unit and install the diaphragm unit. Make sure the control rod enters the throttle valve as the vacuum unit is installed.

(53) Torque the diaphragm unit to 15 - 23 ft. lb.

(54) Position the fluid screen under the rear clip and over the front pump inlet tube. Press the screen down firmly. Install the screen retaining clip.

(55) Place a new gasket on the transmission case and install the pan. Install the attaching bolts and lockwashers and torque the bolts to 10 - 13 ft/lbs.

(56) If the converter and converter housing were removed from the transmission, install these components. Refer to paragraph 7-11.

7-13. Control Valve Body

a. Removal.

(1) Drain the fluid from the transmission by loosening the pan attaching bolts starting at the rear of the pan and working toward the front. When most of the fluid has drained from the pan, remove the remainder of the attaching bolts.

(2) Remove the pan and gasket. Discard the gasket. If the same fluid is to be used again in the transmission, filter the fluid through a 100-mesh screen as it drains from the transmission. Re-use the fluid only if it is in good condition.

(3) Remove the fluid screen retaining clip and the screen.

(4) Disconnect the hoses from the vacuum diaphragm unit. Remove the diaphragm unit using Snap-On Tool S8696-A. Do not use any tools on the diaphragm housing, such as pliers, pipe wrenches, etc. Do not allow solvents to enter the diaphragm unit. Remove the pushrod.

(5) Remove the small compensator pressure tube (fig. 7-14).

(6) Remove the main pressure oil tube first, by gently prying up the end that connects to the main control valve assembly, then, remove the other end of the tube from the pressure regulator. Be sure to remove the tube in this manner. Failure to do so could kink or bend the tube causing excessive transmission internal leakage.

(7) Loosen the front servo attaching bolts three turns.

(8) Remove the three control valve body attaching bolts, and lower the valve body while pulling it off the front servo tube. Be careful not to damage the valve body or the tubes.

b. Disassembly. During the disassembly of the control valve assembly, avoid damage to valve parts and keep the valve parts clean. Place the valve assembly on a clean shop towel while performing the disassembly operation. Do not separate the upper and lower valve bodies and cover until after the valves have been removed.

(1) Refer to figure 7-15, and remove the manual valve.

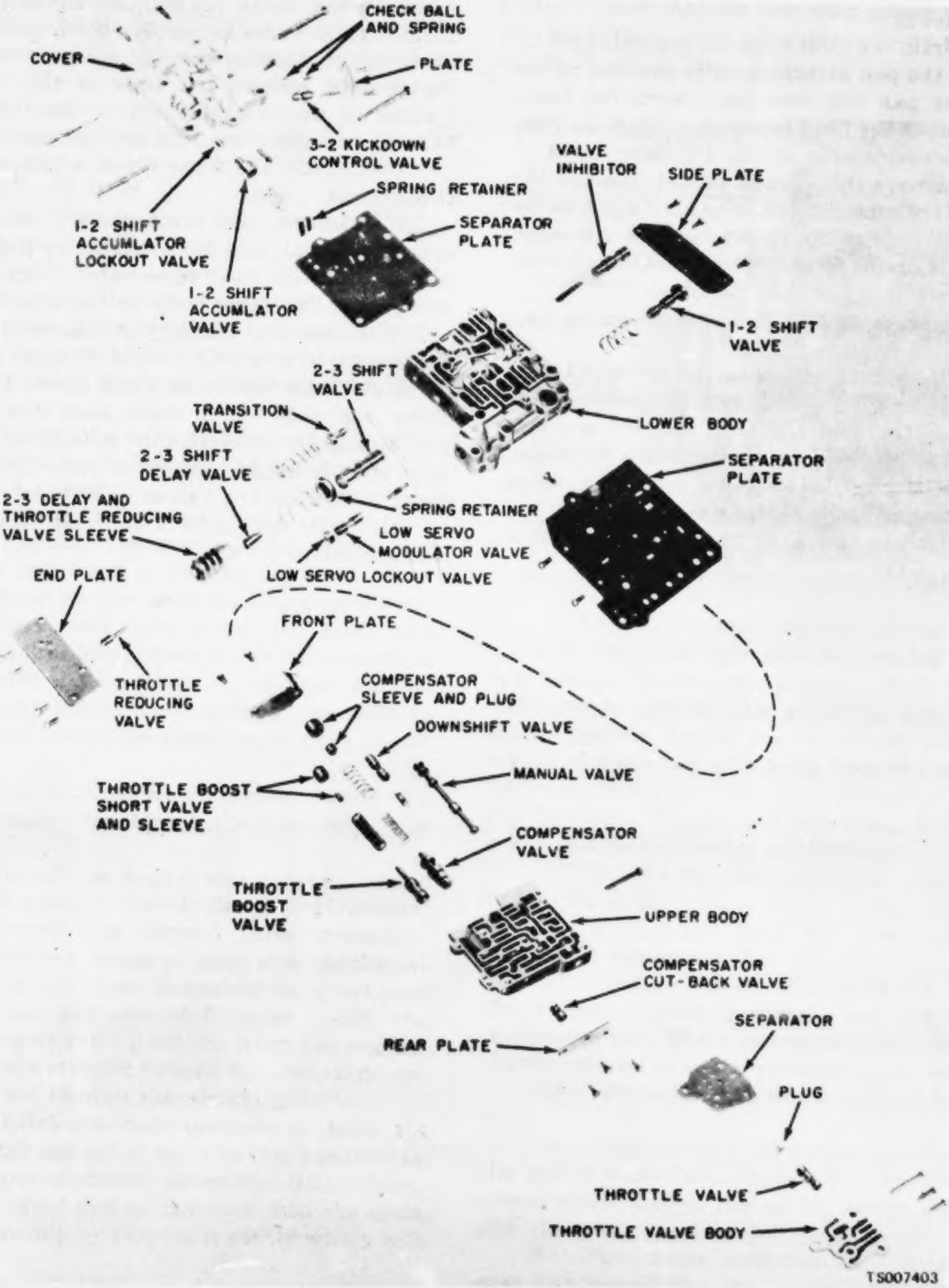

CHECK BALL AND SPRING
COVER
PLATE
3-2 KICKDOWN CONTROL VALVE
VALVE INHIBITOR
SIDE PLATE
SPRING RETAINER
SEPARATOR PLATE
1-2 SHIFT ACCUMLATOR LOCKOUT VALVE
1-2 SHIFT ACCUMLATOR VALVE
1-2 SHIFT VALVE
2-3 SHIFT VALVE
TRANSITION VALVE
LOWER BODY
2-3 SHIFT DELAY VALVE
SEPARATOR PLATE
2-3 DELAY AND THROTTLE REDUCING VALVE SLEEVE
SPRING RETAINER
LOW SERVO MODULATOR VALVE
END PLATE
LOW SERVO LOCKOUT VALVE
FRONT PLATE
THROTTLE REDUCING VALVE
COMPENSATOR SLEEVE AND PLUG
DOWNSHIFT VALVE
MANUAL VALVE
THROTTLE BOOST SHORT VALVE AND SLEEVE
COMPENSATOR VALVE
THROTTLE BOOST VALVE
UPPER BODY
COMPENSATOR CUT-BACK VALVE
SEPARATOR
REAR PLATE
PLUG
THROTTLE VALVE
THROTTLE VALVE BODY
TS007403

Figure 7-15. Control Valve Body.

(2) Remove the throttle valve body and the separator plate. Be careful not to lose the check valve when removing the separator plate from the valve body. Remove the throttle valve and plug.

(3) Remove one screw attaching the separator plate to the lower valve body. Remove the upper body front plate. The plate is spring-loaded. Apply pressure to the plate while removing the attaching screws.

(4) Remove the compensator sleeve and

plug, and remove the compensator valve springs. Remove the compensator valve.

(5) Remove the throttle boost short valve and sleeve. Remove the throttle boost valve spring and valve.

(6) Remove the downshift valve and spring.

(7) Remove the upper valve body rear plate.

(8) Remove the compensator cut back valve.

(9) Remove the lower body side plate. The plate is spring-loaded. Apply pressure to the plate while removing the attaching screws.

(10) Remove the 1-2 shift valve and spring. Remove the inhibitor valve and spring.

(11) Remove the two screws attaching the separator plate to the cover. Remove the lower body end plate. The end plate is spring-loaded. Apply pressure to the plate while removing the attaching screws.

(12) Remove the low servo lockout valve, low servo modulator valve and spring.

(13) Remove the 2-3 delay and throttle reducing valve sleeve, the throttle reducing valve, spring, and the 2-3 shift delay valve. The reducing valve sleeve is lightly staked in the valve body bore. To remove the sleeve, use a blunt instrument against the end of the 2-3 shift valve and push the sleeve from its bore. Remove the 2-3 shift valve spring, spring retainer and valve.

(14) Remove the transition valve spring and valve.

(15) Remove the plate from the valve body cover.

(16) Remove the check ball spring and check ball. Remove the 3-2 kickdown control valve spring and valve.

(17) Remove the 1-2 shift accumulator valve spring retainer from the cover. Remove the spring, 1-2 shift accumulator valve and 1-2 shift accumulator lockout valve.

(18) Remove the through bolts and screws. Then, separate the bodies. Remove the separator plates from the valve bodies and cover. Be careful not to lose the check valves.

c. *Cleaning and Inspection.*

(1) Clean all parts thoroughly in clean solvent, and then blow them dry with moisture-free compressed air.

(2) Inspect all valve and plug bores for scores. Check all fluid passages for obstructions. Inspect the check valve for free movement. Inspect all mating surfaces for burrs or distortion. Inspect all plugs and valves for burrs or scores. Crocus cloth can be used to polish valves and plugs if care is taken to avoid rounding the sharp edges of the valves and plugs.

(3) Inspect all springs for distortion. Check all valves and plugs for free movement in their respective bores. Valves and plugs, when dry, must fall from their own weight in their respective bores.

(4) Roll the manual valve on a flat surface to check it for a bent condition.

d. *Reassembly.*

(1) Arrange all parts in their correct positions (fig. 7-15) Rotate the valves and plugs when inserting them in their bores to avoid shearing of soft body castings.

(2) Place the check valve in the upper body as shown in figure 7-16. Then, position the separator plate on the body.

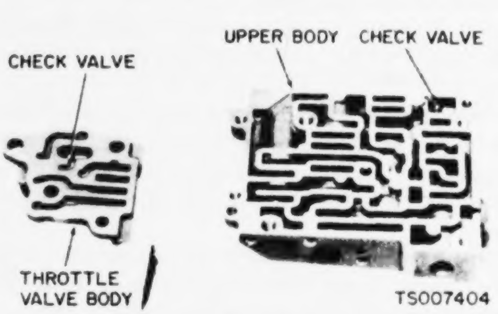


Figure 7-16. Check Valve Locations.

(3) Position the lower body on the upper body, and start but do not tighten the attaching screws.

(4) Position the cover and separator plate on the lower body. Start the four through bolts.

(5) Align the separator with the upper and lower valve body attaching bolt holes. Install and torque the four valve body bolts to 20—30 in./lbs. Excessive tightening of these bolts may distort the valve bodies, causing valves or plugs to stick.

(6) Install the 3-2 kickdown control valve and spring and the check ball and spring in the cover. Install the plate (fig. 7-15).

(7) Insert the 1-2 shift accumulator lockout valve, 1-2 shift accumulator valve, and spring in the cover. Install the valve spring retainer.

(8) Install the transition valve and spring in the lower body.

(9) Install the 2-3 shift valve, spring retainer and spring. Install the 2-3 shift delay valve and the spring and throttle reducing valve in the sleeve. Slide the sleeve and valve into position in the lower body. Do not restake the sleeve.

(10) Install the low servo lockout valve spring. Install the low servo modulator and low servo lockout valves. Install the lower body end plate.

(11) Install the inhibitor valve spring and valve in the lower body.

(12) Install the 1-2 shift valve spring and valve. Install the lower body side plate.

(13) Install the compensator cutback valve in the upper body. Install the upper body rear plate.

(14) Install the downshift valve and spring in the body.

(15) Install the throttle boost valve and spring. Install the throttle boost short valve and sleeve.

(16) Install the compensator valve, inner and outer compensator springs, and the compensator sleeve and plug.

(17) Position the front plate. Apply pressure to the plate while installing the two attaching screws.

(18) Install the throttle valve, plug and check valve in the throttle valve body. Position the separator on the upper body and install the throttle valve body. Install the three attaching screws.

(19) Install four screws attaching the cover to the lower body, two screws attaching the separator plate to the upper body, and one screw attaching the separator plate to lower body. Torque the cover and body screws to 20—30 in./lbs.

(20) Install the manual valve.

e. Installation.

(1) Before installing the control valve body, check for a bent manual valve by rolling it on a flat surface.

(2) Install the control valve body by aligning the front servo tubes with the holes in the valve body. Shift the manual lever to the 1 detent, and place the inner downshift lever between the downshift lever stop and the downshift valve. The manual valve must engage the actuating pin in the manual detent lever.

(3) Install but do not tighten the control valve body attaching bolts.

(4) Move the control valve body toward the center of the case until the clearance is less than 0.050 inch, between the manual valve and the actuating pin on the manual detent lever.

(5) Torque the attaching bolts to specification. Be sure that the rear fluid screen retaining clip is installed under the valve body as shown in figure 7-14.

(6) Install the main pressure oil tube. Be sure to install the end of the tube that connects to the pressure regulator first. Then, install the other end of the tube into the main control valve assembly by tapping it gently with a soft hammer.

(7) Install the compensator pressure tube to the pressure regulator and the control valve body.

(8) Turn the manual valve one full turn in each manual lever detent position. If the manual valve binds against the actuating pin in any detent position, loosen the valve body attaching bolts and move the body away from the center of the case. Move the valve body only enough to relieve the binding. Torque the attaching bolts and recheck the manual valve for binding.

(9) Position the pushrod in the bore of the vacuum diaphragm unit. Using the diaphragm unit as a guide, insert the pushrod into the threaded opening of the case. Torque the diaphragm unit to 15—23 ft/lbs. Connect the vacuum hone.

(10) Torque the front servo attaching bolts to 30—35 ft/lbs.

(11) Adjust the front band (paragraph 7-5).

(12) Install the fluid screen and the screen retaining clip.

(13) Position a new pan gasket on the bottom of the transmission case, and install the pan. Torque the pan screws to 10—13 ft/lbs.

(14) Adjust the rear band (para 7-5).

7-14. Front Servo

a. Removal.

(1) Drain the fluid from the transmission, and remove the pan and fluid screen.

(2) Remove the vacuum diaphragm unit.

(3) Loosen the three control valve body attaching bolts.

(4) Remove the attaching bolts from the front servo (fig. 7-14). Hold the strut with the fingers and remove the servo.

b. Disassembly.

(1) Refer to figure 7-17 and remove the servo piston retainer snap ring. Apply pressure to the piston when removing the snap ring.

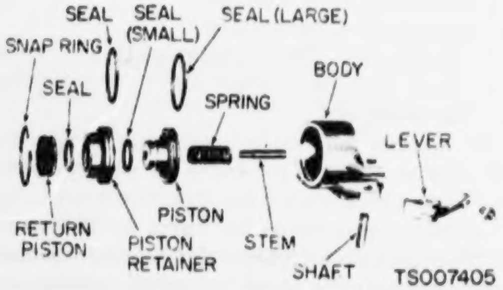


Figure 7-17. Front Servo.

(2) Remove the servo piston retainer, servo piston, and the return piston from the servo body. It may be necessary to tap the piston stem lightly with a soft-faced hammer to separate the piston retainer from the servo body.

(3) Remove all the seal rings, and remove the spring from the servo body.

c. Inspection.

(1) Inspect the servo bore for cracks and the piston bore and the servo piston stem for scores. Check fluid passages for obstructions. Replace seals that are damaged.

(2) Check the actuating lever for free movement, and inspect it for wear. To replace the actuating lever shaft, it will be necessary to press the shaft out of the bracket. The shaft is retained in the body by serrations on one end of the shaft. These serrations cause a press fit at that end. To remove the shaft, press on the end opposite the serrations. Inspect the adjusting screw threads and the threads in the lever.

(3) Check the servo spring and servo band strut for distortion.

(4) Inspect the servo band lining for excessive wear and bonding to the metal. The band should be replaced if worn to a point where the grooves are not clearly evident.

(5) Inspect the band ends for cracks and check the band for distortion.

d. Assembly.

(1) Lubricate all parts of the front servo with transmission fluid to facilitate assembly.

(2) Install the inner and outer O-rings on the piston retainer. Install a new O-ring on the return piston and on the servo piston (fig. 7-17).

(3) Position the servo piston release spring in the servo body. Install the servo piston, retainer, and return piston in the servo body as an assembly. Compress the assembly into the body, and secure it with the snap ring. Make sure the snap ring is fully seated in the groove.

(4) Install the adjusting screw and locknut in the actuating lever if they were previously removed.

e. Installation.

(1) To install the front servo, position the front band forward in the case with the end of the band facing downward. Make sure the front servo anchor pin is in position in the case web. Align the large end of the servo strut with the servo actuating lever, and align the small end with the band end.

(2) Rotate the band, strut, and servo to align the anchor end of the band with the anchor in the case. Push the servo body onto the control valve body tubes.

(3) Install the attaching bolts and torque to 30—35 ft/lbs.

(4) Torque the control valve body attaching bolts to 8—10 ft/lbs. Check the clearance between the manual valve and manual lever actuating pin as given in paragraph 7-13.

(5) Adjust the front band.

(6) Install the vacuum diaphragm unit and rod.

(7) Install the fluid screen and pan, and fill the transmission with fluid.

(8) Adjust the downshift and manual linkage.

7-15. Rear Servo

a. Removal.

(1) Drain the fluid from the transmission and remove the pan and fluid screen.

(2) Remove the vacuum diaphragm unit.

(3) Remove the control valve body and the two front servo tubes.

(4) Remove the attaching bolts from the rear servo; hold the actuating and anchor struts with the fingers, and remove the servo.

b. Disassembly.

(1) Remove the servo actuating lever shaft retaining pin with a 1/8-inch punch. See figure 7-18.

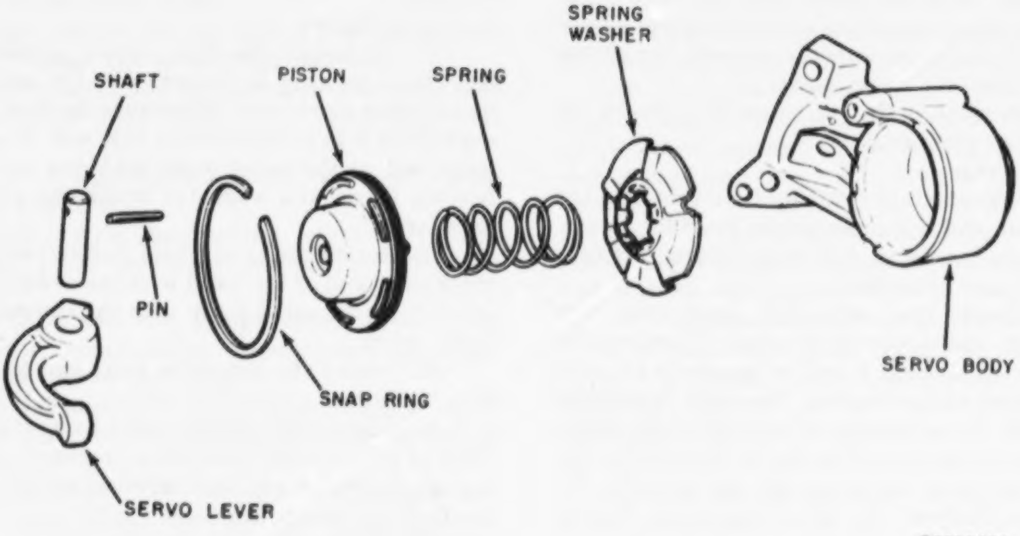


Figure 7-18. Rear Servo.

(2) Press down on the servo piston, and remove the snap ring. Release the pressure on the piston slowly to prevent the spring from flying out.

(3) Remove the piston, servo spring, and spring washer.

c. *Inspection.*

(1) Inspect the servo body for cracks and the piston bore for scores.

(2) Check the fluid passages for obstructions.

(3) Inspect the band and the struts for distortion. Inspect the band ends for cracks.

(4) Inspect the servo spring for distortion.

(5) Inspect the band lining for excessive wear and bonding to the metal band.

(6) Check the servo body to case mating surface for burrs. Check the actuating lever socket for scores.

(7) Replace seals that are damaged.

d. *Assembly.*

(1) Install a new seal ring on the servo piston.

(2) Install the piston in the servo body. Lubricate the parts to facilitate assembly. Install the servo spring with the small coiled end against the servo piston.

(3) Compress the spring with a C-clamp. Then install the snap ring. The snap ring must be fully seated in the groove.

(4) Install the actuating lever shaft, aligning the retaining pin holes, and install the pin.

(5) Check the actuating lever for free movement.

e. *Installation.*

(1) To install the rear servo, position the servo anchor strut on the servo band, and rotate the band to engage the strut.

(2) Hold the servo anchor strut in position with the fingers, position the actuating lever strut, and install the servo.

(3) Install but do not tighten the servo attaching bolts. The longer bolt must be installed in the inner bolt hole.

(4) Move the rear servo (with reasonable force) toward the centerline of the transmission case, against the servo attaching bolts. While holding the servo in this position, torque the attaching bolts to specification.

(5) Install the two front servo tubes and the control valve body. Check the clearance between the manual valve and the manual lever actuating pin as given in paragraph 7-13.

(6) Adjust the rear band (para. 7-5).

(7) Install the fluid screen and pan, and fill the transmission with fluid.

7-16. Extension Housing Seal and Bearing

a. *Removal.*

(1) Remove the parking brake drum and companion flange attaching nut.

(2) With a sharp chisel, remove the seal from the extension housing. Do not allow metal chips to enter the output shaft bearing.

(3) To remove the output shaft bearing from the extension housing, remove the bearing retaining snap ring (fig. 7-19).

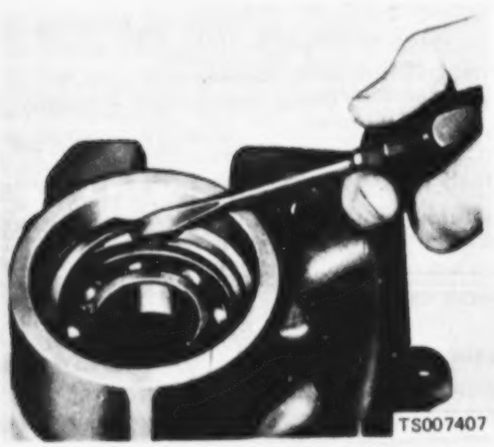


Figure 7-19. Extension Housing Bearing Removal.

(4) Remove the bearing from the extension housing. Install a new bearing.

b. Inspection.

(1) Inspect the housing for cracks. Inspect the gasket surface for burrs or warpage. Check for leakage around the governor inspection cover and gasket. If leakage is found, install a new gasket.

(2) Inspect the bushing for scores or wear.

(3) Inspect the rear seal for hardness, cracks, or wear. If the seal shows wear or deterioration, replace the seal.

(4) Inspect the seal counterbore and remove all burrs and scores with crocus cloth.

c. Installation.

(1) Install the bearing retaining snap ring. Make sure the snap ring is fully seated in the ring groove of the housing.

(2) Install a new extension housing seal using the tool shown in figure 7-20. Install the output shaft flange retaining nut. Torque the attaching nut to 150—200 ft/lbs. Install the parking brake drum.

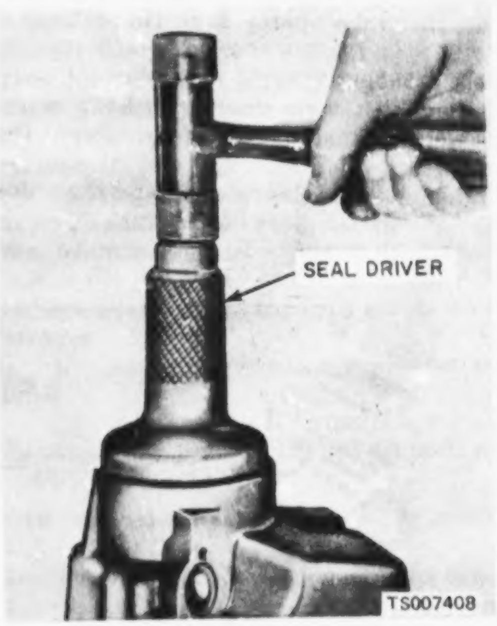


Figure 7-20. Installing Extension Housing Seal.

7-17. Governor

a. Removal.

(1) Remove the governor inspection cov from the extension housing.

(2) Rotate the drive shaft until the govern is in line with the inspection hole (fig. 7-21).

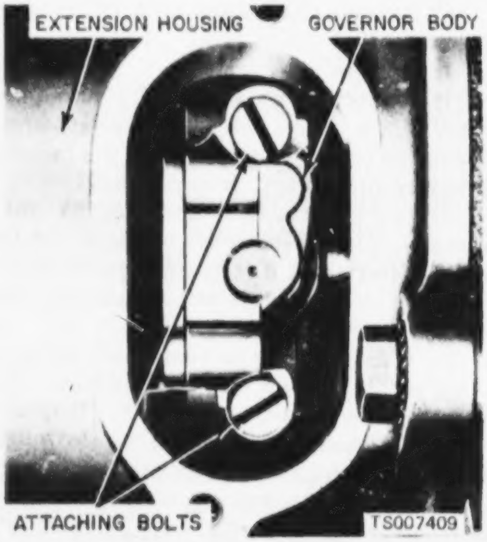


Figure 7-21. Governor Installed.

(3) Remove the governor valve body from the counterweight. Do not drop the attaching bolts or the valve parts into the extension housing.

b. Disassembly.

(1) Remove the governor valve body cover.

(2) Remove the valve body from the counterweight.

(3) Remove the plug, sleeve, and the valve and spring from the body (fig. 7-22).

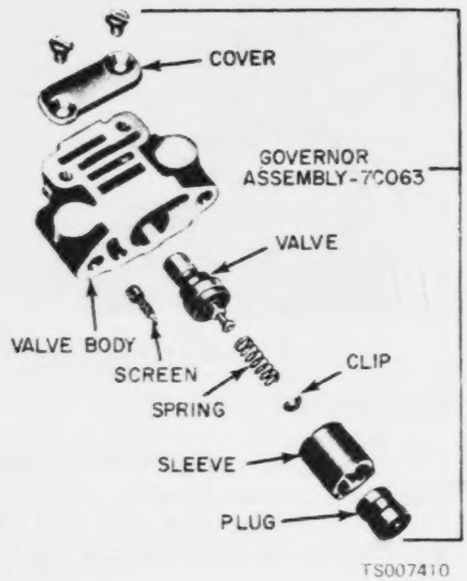


Figure 7-22. Governor Parts.

(4) Remove the screen from its bore in the valve body.

c. Inspection.

(1) Inspect the governor valves and bores for scores. Minor scores may be removed from the valves with crocus cloth. Replace the governor if the valves or body is deeply scored.

(2) Inspect the governor screen for obstructions. The screen must be clean and free of foreign material. If it is contaminated, it should be cleaned in a suitable solvent and thoroughly blown out with compressed air.

(3) Check for free movement of the valves in the bores. The valves should slide freely of their own weight in the bores when dry. Inspect fluid passages in the valve body and counterweight for obstructions. All fluid passages must be clean.

(4) Check the mating surface of governor valve and the counterweight for burrs or scratches.

d. Assembly.

(1) Install the governor valve and spring assembly in the bore of the valve body. Install the sleeve, and plug.

(2) Install the screen.

(3) Install the body on the counterweight. Make sure the fluid passages in the body and the counterweight are aligned.

(4) Position the valve body cover on the body, and install the screws.

e. Installation.

(1) Lubricate the new governor valve parts with transmission fluid. The valve must move freely in the valve body bore.

(2) Install the governor body on the counterweight so that the valve body cover is facing rearward. Tighten the two attaching bolts securely.

(3) Install the governor inspection cover, using a new gasket.

7-18. Pressure Regulator

a. Removal.

(1) Drain the fluid from the transmission, and remove the pan and fluid screen.

(2) Remove the small compensator pressure tube from the control valve body and the pressure regulator (fig. 7-14).

(3) Remove the main pressure oil tube first, by gently prying up the end that connects to the main control valve assembly. Then, remove the other end of the tube from the pressure regulator. Be sure to remove the tube in this manner. Failure to do so could kink or bend the tube, causing excessive transmission internal leakage.

(4) Remove the pressure regulator spring retainer, springs and spacer. Maintain pressure on the retainer to prevent the springs from flying out.

(5) Remove the pressure regulator attaching bolts and washers, and remove the regulator.

b. Disassembly and Inspection.

(1) Remove the valves from the regulator body.

(2) Remove the regulator body cover attaching screws and remove the cover (fig. 7-23).

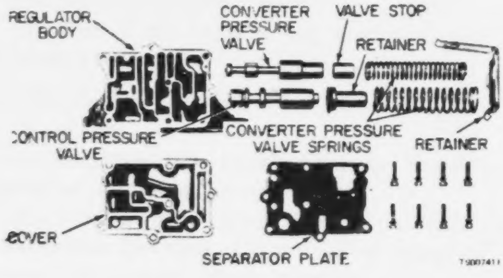


Figure 7-23. Pressure Regulator Parts.

(3) Remove the separator plate.

(4) Wash all parts thoroughly in clean solvent and blow dry with moisture-free compressed air.

(5) Inspect the regulator body and cover mating surfaces for burrs.

(6) Check all fluid passages for obstructions.

(7) Inspect the control pressure and converter pressure valves and bores for burrs and scores. Remove all burrs carefully with crocus cloth.

(8) Check the free movement of the valves in their bores. Each valve should fall freely into its bore when both the valve and bore are dry.

(9) Inspect the valve springs for distortion.

c. Assembly.

(1) Position the separator plate on the regulator cover.

(2) Position the regulator cover and separator plate on the regulator body, and install the attaching screws. Torque the screws to 20—30 in./lbs.

(3) Insert the valves in the pressure regulator body (fig. 7-23).

d. Installation.

(1) Position the replacement regulator body on the transmission case and install the two attaching bolts. Torque the bolts to 17—22 ft/lbs.

(2) Check the converter pressure and control pressure valves to be sure the valves operate freely in the bores.

(3) Install the valve springs, spacer and retainer.

(4) Install the main pressure oil tube. Be sure to install the end of the tube that connects to the pressure regulator assembly first. Then, install the other end of the tube into the main control assembly by tapping it gently with a soft hammer.

(5) Install the small compensator pressure tube.

(6) Install the fluid screen and the pan, and fill the transmission to the correct level with the specified fluid.

7-19. Manual Linkage

a. Disassembly.

(1) Remove the inner downshift lever shaft nut (fig. 7-24). Then remove the inner downshift lever.

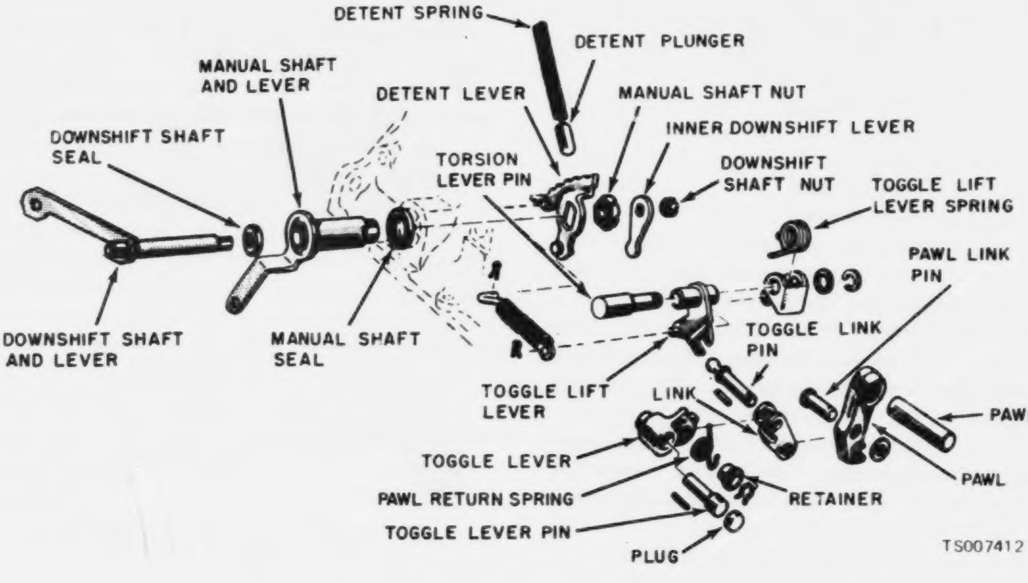

DETENT SPRING
DETENT PLUNGER
MANUAL SHAFT AND LEVER
DETENT LEVER
MANUAL SHAFT NUT
INNER DOWNSHIFT LEVER
DOWNSHIFT SHAFT SEAL
TORSION LEVER PIN
DOWNSHIFT SHAFT NUT
TOGGLE LIFT LEVER SPRING
PAWL LINK PIN
DOWNSHIFT SHAFT AND LEVER
MANUAL SHAFT SEAL
TOGGLE LINK PIN
TOGGLE LIFT LEVER
LINK
PAWL PIN
TOGGLE LEVER
PAWL
PAWL RETURN SPRING
RETAINER
TOGGLE LEVER PIN
PLUG
TS007412

Figure 7-24. Manual Linkage.

(2) Remove the outer downshift lever and shaft. Remove the downshift shaft seal from the counterbore in the manual lever shaft.

(3) Remove the cotter pin from the parking pawl toggle operating rod and remove the clip from the parking pawl operating lever. Remove the parking pawl operating rod.

(4) Rotate the manual shaft until the detent lever clears the detent plunger. Then remove the detent plunger and spring. Do not allow the detent plunger to fly out of the case.

(5) Remove the manual lever shaft nut, and remove the detent lever. Remove the outer

manual lever and shaft from the transmission case.

(6) Tap the toggle lever sharply toward the rear of the case to remove the plug and pin.

(7) Remove the pawl pin by working the pawl back and forth. Remove the pawl and toggle lever assembly, and then disassemble.

(8) Remove the manual shaft seal and case vent tube.

b. Assembly.

(1) Coat the outer diameter of a new manual shaft seal with sealer, then install the seal in the case with a driver.

(2) Install the vent tube in the transmission case.

(3) Assemble the link to the pawl with the pawl link pin, washer, and pawl return spring. Assemble the toggle lever to the link with the toggle link pin. Position the pawl return spring over the toggle link pin, and secure it in place with the washer and the small retainer clip. Install the assembly in the transmission case by installing the pawl pin and the toggle lever pin. Install the torsion lever assembly. Position the spring on the torsion lever with a screwdriver. Make certain that the short side of toggle does not extend beyond the largest diameter of the ball or the toggle lever pin. Tap the toggle lever in or out as necessary to center the toggle lever on the ball.

(4) Install the manual lever and shaft in the transmission case. Position the detent lever on the shaft, and secure it with a nut. Tighten the nut to 20—30 ft/lbs torque. Rotate the manual lever to the rear of the case. Position the detent spring in the case. Hold the detent plug on the spring with a 3/16 inch socket wrench, then depress the spring until the plug is flush with the case. Carefully rotate the manual lever to the front of the case to secure the plug. A piece of thin walled tubing may be used to depress the plug if a small socket wrench is not available.

(5) Position the ends of the parking pawl operating rod in the detent lever and toggle lift lever, and secure with the two small retaining pins.

(6) Install a new seal on the downshift lever shaft, then install the lever and shaft in the case. Position the inner downshift lever on the inner end of the shaft with the mark 0 facing toward the center of the case. Install the lockwasher and nut, then tighten the nut to 17—20 ft/lbs torque.

(7) Check the operation of the linkage. The linkage should operate freely without binding.

7-20. Front Pump

a. Disassembly.

(1) Remove the stator support attaching screws and remove the stator support. Mark the top surface of the pump driven gear with Prussian blue to assure correct assembly. Do not scratch the pump gears.

(2) Remove the drive and driven gears from the pump body.

(3) Refer to figure 7-25 for a disasembled view of the front pump. Inspect the pump body housing, gear pockets and crescent for scores.

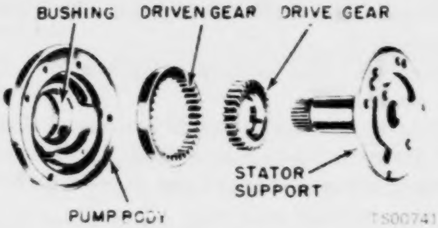


Figure 7-25. Front Pump.

(4) If the front pump housing bushing requires replacement, refer the unit to depot maintenance.

(5) If any parts other than the stator support, bushings or oil seal are found defective, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth. The stator support is serviced separately.

(6) Bolt the front pump to the transmission case with capscrews.

(7) If the oil seal requires replacement, install the oil seal remover shown in figure 7-26. Then pull the front seal from the pump body.

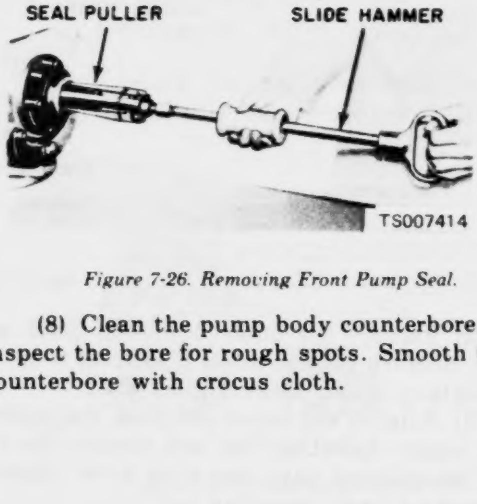


Figure 7-26. Removing Front Pump Seal.

(8) Clean the pump body counterbore. Then inspect the bore for rough spots. Smooth up the counterbore with crocus cloth.

(9) Remove the pump body from the transmission case.

b. Inspection.

(1) Inspect the mating surfaces of the pump body and cover for burrs.

(2) Inspect the drive and driven gear bearing surface for scores, and check the gear teeth for burrs.

(3) Check the fluid passages for obstructions.

(4) If any parts are found defective, replace the pump as a unit. Minor burrs and scores may be removed with crocus cloth.

c. Assembly and Installation.

(1) Install new oil seal into front pump cover, using a seal driver as shown in figure 7-27.

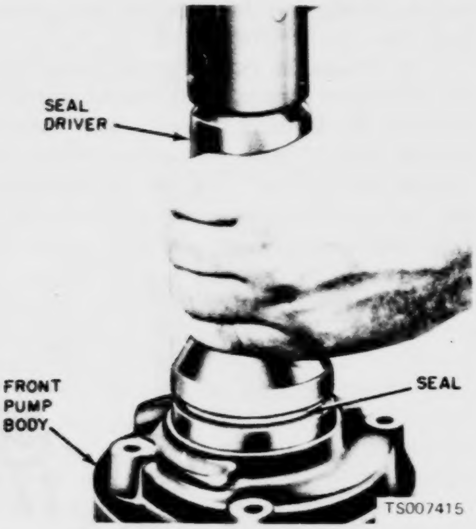


Figure 7-27. Installing Front Pump Seal.

(2) Place the pump driven gear in the pump body with the mark on the gear facing down. Install the drive gear in the pump body with the chamfered side of the flats facing down.

(3) Install the stator support and attaching screws. Check the pump gears for free rotation.

7-21. Rear Pump

a. Disassembly.

(1) Remove the screws and lockwashers which secure the pump cover to the pump body, and remove the cover.

(2) Remove the drive gear from the pump body.

b. Inspection.

(1) Remove the drive gear from the pump body.

(2) Inspect the gear pocket of the pump body for scores or pitting.

(3) Inspect the inner bushing and the drive gear bearing surface for scores.

(4) Check all fluid passages for obstructions, and check mating surfaces and gasket surfaces of the pump body and cover for burrs.

(5) Inspect the pump cover bearing surface for scores. Minor burrs or scores may be removed with crocus cloth.

c. Assembly.

(1) Install the drive gear in the pump body.

(2) Install the pump cover, attaching screws and lockwashers. Torque the screws to 25—35 in./lbs.

7-22. Rear Clutch

a. Disassembly.

(1) Remove the clutch pressure plate snap ring, and remove the pressure plate from the drum. Remove the waved cushion spring. Remove the composition and steel plates.

(2) Compress the spring with the tools shown in figure 7-28 and remove the snap ring.

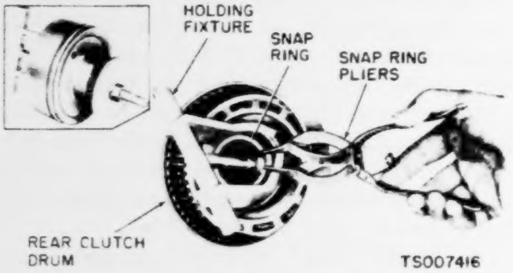


Figure 7-28. Removing Snap Ring.

(3) Guide the spring retainer while releasing the pressure to prevent the retainer from locking in the snap ring grooves.

(4) Position the primary sun gear shaft in the rear clutch. Place an air hose nozzle in one of the holes in the shaft, and place one finger over the other hole. Then force the clutch piston out of the clutch drum with air pressure. Hold one hand over the piston to prevent damage to the piston.

(5) Remove the inner and outer seal rings from the clutch piston.

(6) If the rear clutch sun gear is worn or damaged, replace the gear and drum assembly.

b. Inspection.

(1) Inspect the drum band surface, the bushing, and thrust surfaces for scores. Minor scores may be removed with crocus cloth. Badly scored parts must be replaced. Inspect the clutch piston bore and the piston inner and outer bearing surfaces for scores. Check the air bleed ball valve

in the clutch piston for free movement. Check the orifice to make sure it is not plugged.

(2) Check the fluid passages for obstructions. All fluid passages must be clean and free of obstructions.

(3) Inspect the clutch plates for wear and scoring and check the plates for fit on the clutch hub serrations. Replace all plates that are badly scored, worn or do not fit freely in the hub serrations.

(4) Inspect the clutch pressure plate for scores on the clutch plate bearing surface. Check the clutch release spring(s) for distortion.

(5) Inspect the needle bearing for worn rollers.

c. Assembly.

(1) Install new inner and outer seal rings on the piston.

(2) Lubricate seals and install piston into cylinder, being careful not to damage seal rings.

(3) Install the clutch release spring, and position the retainer on the spring.

(4) Install the tool on the spring retainer as shown in figure 7-28. Compress the clutch spring, and install the snap ring. While compressing the spring, guide the retainer to avoid interference of the retainer with the snap ring groove. Make sure the snap ring is fully seated in the groove. When new composition clutch plates are used, soak the plates in automatic transmission fluid for 15 minutes before they are assembled.

(5) Install the external tabbed waved cushion spring. Then, install the composition and the steel clutch plates alternately, starting with a steel plate.

(6) Install the clutch pressure plate with the bearing surface down. Then install the clutch pressure plate snap ring. Make sure the snap ring is fully seated in the groove.

(7) Check the free pack clearance between the pressure plate and the first internal plate with a feeler gage. The clearance should be 0.030-0.055 inch. If the clearance is not within specifications, selective snap rings are available in the following thicknesses: 0.060-0.064, 0.074-0.078, 0.088-0.092 and 0.102-0.106 inch. Insert the correct size snap ring and recheck the clearance.

(8) Install the thrust washer on the primary sun gear shaft. Be sure the thrust washer is installed with the tabs of the washer away from the sun gear thrust face. Lubricate all parts with automatic transmission fluid or petroleum jelly. Install the two center seal rings.

(9) Install the rear clutch on the primary sun gear shaft. Be sure all of the needles are in the hub if the unit is equipped with loose needle bearings. Assemble two seal rings in the front grooves.

(10) Install the steel and the bronze thrust washers on the front of the secondary sun gear assembly. If the steel washer is chamfered, place the chamfered side down.

7-23. Front Clutch

a. Disassembly.

(1) Remove the clutch cover snap rings with a screwdriver, and remove the input shaft from the clutch drum.

(2) Remove the thrust washer from the thrust surface of the clutch hub. Insert one finger in the clutch hub, and lift the hub straight up to remove the hub from the clutch drum.

(3) Remove the composition and the steel clutch plates, and then remove the pressure plate from the clutch drum.

(4) Place the front clutch spring compressor on the release spring. Position the clutch drum on the bed of an arbor press, and compress the release spring with the arbor press until the release spring snap ring can be removed (fig. 7-29).

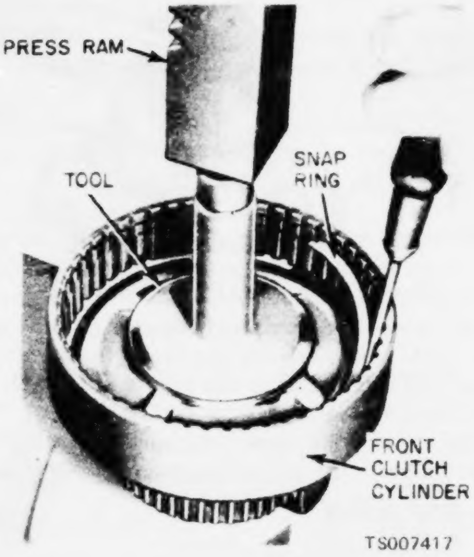


Figure 7-29. Removing Front Clutch Snap Ring.

(5) Remove the clutch release spring from the clutch drum.

(6) The piston can be forced out of the housing with air pressure. Place the nozzle against the clutch apply hole in the front clutch housing, and force the piston out of the housing. See figure 7-30.

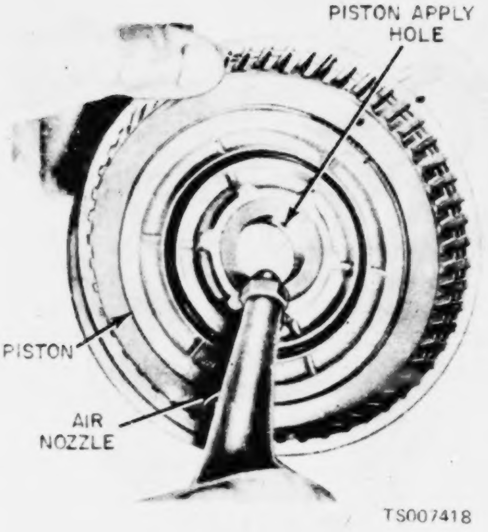


Figure 7-30. Removing Piston.

(7) Remove the piston inner seal from the clutch housing. Remove the piston outer seal from the groove in the piston.

(8) If the input shaft bushing is worn or damaged, replace the drum.

b. Inspection.

(1) Inspect the clutch cylinder thrust surfaces, piston bore, and clutch plate serrations for scores or burrs. Minor scores or burrs may be removed with crocus cloth. Replace the clutch cylinder if it is badly scored or damaged.

(2) Check the fluid passages in the clutch cylinder for obstructions. Clean out all fluid passages. Inspect the clutch piston for scores and replace if necessary. Inspect the piston check ball for freedom of movement and proper seating (fig. 7-31).

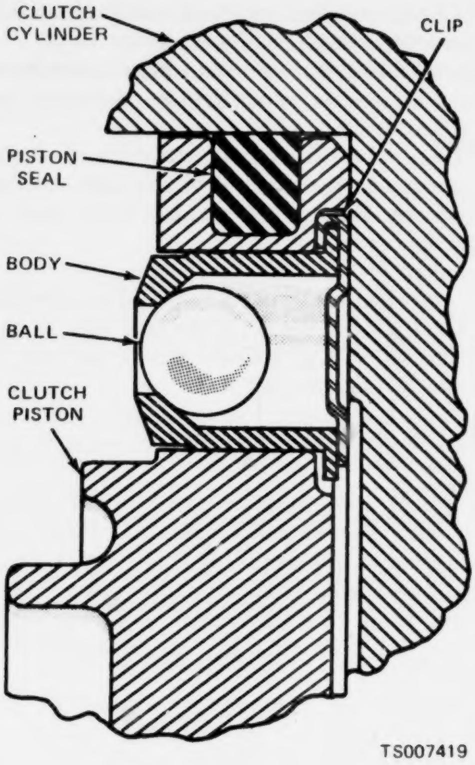


Figure 7-31. Clutch Piston Check Ball.

(3) Check the clutch release spring for distortion and cracks. Replace the spring if it is distorted or cracked.

(4) Inspect the composition and the steel clutch plates and the clutch pressure plate for worn or scored bearing surfaces. Replace all parts that are deeply scored.

(5) Check the clutch plates for flatness and fit on the clutch hub serrations. Discard any plate

that does not slide freely on the serrations or that is not flat.

(6) Check the clutch hub thrust surfaces for scores and the clutch hub splines for wear.

(7) Inspect the turbine shaft bearing surfaces for scores. If excessive clearance or scores are found, discard the unit.

(8) Check the splines on the turbine shaft for wear and replace the shaft if the splines are excessively worn. Inspect the bushing in the turbine shaft for scores.

c. *Assembly.*

(1) Lubricate all parts with transmission fluid. Install a new piston inner seal ring in the clutch cylinder. Install a new piston outer seal in the groove in the piston.

(2) Install the piston in the clutch housing. Make sure the steel bearing ring is in place on the piston.

(3) Position the release spring in the clutch cylinder with the concave side up. Place the release spring compressor on the spring, and compress the spring with an arbor press. Then install the snap ring as shown in figure 7-29. Make sure the snap ring is fully seated in the groove.

(4) Install the front clutch housing on the primary sun gear shaft by rotating the clutch units to mesh the rear clutch plates with the serrations on the clutch hub. Do not break the seal rings.

(5) Install the clutch hub in the clutch cylinder with the deep counterbore down (fig. 7-32). Install the thrust washer on the clutch hub.

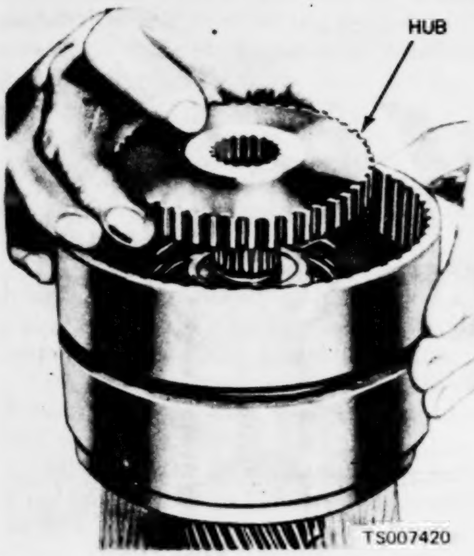


Figure 7-32. Installing Front Clutch Hub.

(6) Install the pressure plate in the clutch cylinder with the bearing surface up (figure 7-33). Install the composition and the steel clutch plates alternately, starting with a composition plate (fig. 7-34). When new composition clutch plates are used, soak the plates in automatic transmission fluid for 15 minutes before they are assembled.

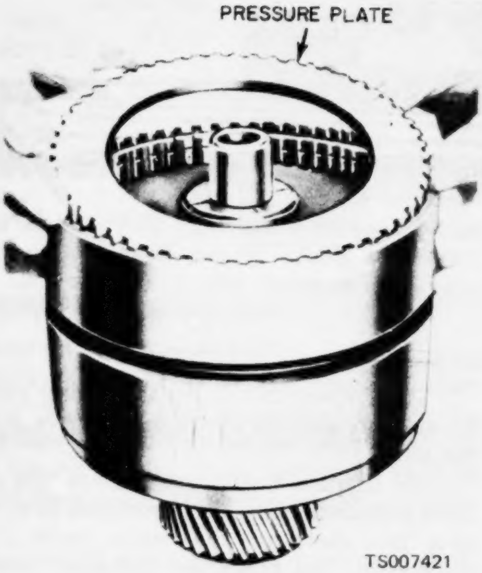


Figure 7-33. Installing Pressure Plate.

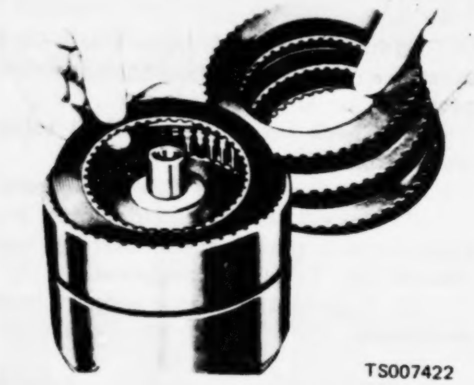


Figure 7-34. Installing Clutch Plates.

(7) The final friction plate to be installed is selective. Install the thickest plate that will be a minimum of 0.010 inch below input shaft shoulder in cylinder. For all other plates, use the thinnest available. Refer to TM 10-3930-633-34P for available plate thicknesses.

(8) Install the turbine shaft in the clutch cylinder, and then install the snap ring. Make sure the snap ring is fully seated in the groove.

(9) Install the thrust washer on the turbine shaft.

7-24. Component Inspection

Prior to reassembly of the transmission, check for damage to the case and other parts as outlined below:

a. Case.

(1) Inspect the case for cracks and stripped threads. Inspect the gasket surfaces and mating surfaces for burrs. Check the vent for obstructions, and check all fluid passages for obstructions and leakage.

(2) Inspect the case bushing for scores. Check all parking linkage parts for wear or damage.

(3) Use helicoil inserts to repair damaged threads.

b. Primary Sun Gear Shaft.

(1) Inspect the primary sun gear for broken or worn teeth. Inspect all thrust surfaces and journals for scores. Check all fluid passages for obstructions and leakage. Inspect the seal ring grooves for burrs. Refer to figure 7-35.

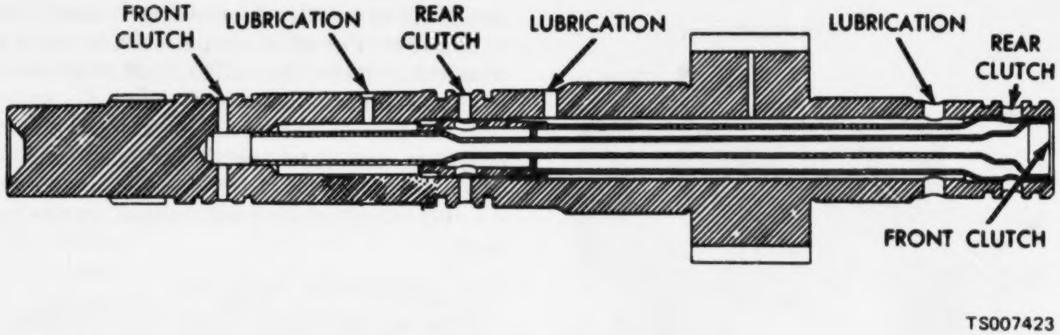


Figure 7-35. Primary Sun Gear Shaft.

(2) Inspect the sun gear shaft splines for burrs and wear.

(3) Check the fit of the seal rings in the grooves of the shaft. The rings should enter the grooves freely without bind.

(4) Check the fit of the seal rings in their respective bores. A clearance of 0.002-0.009 inch should exist between the ends of the rings.

(5) Install the seal rings on the shaft and check for free movement in the grooves.

c. *One-way Clutch.*

(1) Inspect the outer and inner races for scores or damaged surface area where the rollers contact the races. If the outer race is damaged on the low reverse clutch hub, it must be replaced.

(2) Inspect the rollers and springs for excessive wear or damage.

(3) Inspect the spring and roller case for bent or damaged spring retainers.

d. *Output Shaft.*

(1) Inspect the thrust surfaces and journals for scores. Inspect the internal gear for broken or worn teeth.

(2) Inspect the ring grooves for burrs.

(3) Inspect the keyway and drive ball pocket for wear, and inspect the splines for burrs, twist or wear.

(4) Inspect the external parking gear teeth for damage and the speedometer drive gear teeth for burrs.

(5) If either the output shaft or ring gear has been replaced, place the assembled unit with the gear face down on the bench, push the shaft downward, and check the clearance between the top of the snap ring and its groove. If this clearance exceeds 0.002 inch, replace the snap ring with a thicker ring to reduce the clearance to less than 0.002 inch. Selective snap rings are available in several thicknesses for this purpose.

e. *Distributor Sleeve.*

(1) Inspect the distributor sleeve for scores or excessive ring wear. Inspect the distributor sleeve passages for obstructions.

(2) Check the fit of the fluid tubes in the distributors.

f. *Planet Carrier and Center Support.*

(1) Inspect the clutch outer race, inner race, band surface, pinion gears, bearings and thrust washer (fig. 7-12) for roughness.

(2) Inspect the center support bushing for roughness.

CHAPTER 8

REPAIR OF PROPELLER SHAFT

8-1. General

The propeller shaft transmits the power from the output shaft of the transmission to the input shaft of the rear axle reduction gearcase. Design features of the shaft permit changes in shaft length and relative angles between axle and transmission while under load.

8-2. Removal and Installation

a. Removal. Removal of the propeller shaft from the vehicle is best accomplished with the flange yokes intact. Proceed as follows:

(1) Set the parking brake firmly and block all wheels of the vehicle. Have the vehicle on a level surface.

(2) Remove the capscrews, nuts and lockwashers securing the flange yoke to the parking brake drum on the transmission output shaft.

(3) Remove the capscrews, nuts and lockwashers securing the flange yoke to the input flange on the rear axle reduction gearcase.

(4) Collapse the shaft slightly, which will allow removal of the shaft assembly from between the transmission and axle.

b. Installation.

(1) Collapse the shaft slightly to allow fitting up between the parking brake drum and axle input shaft.

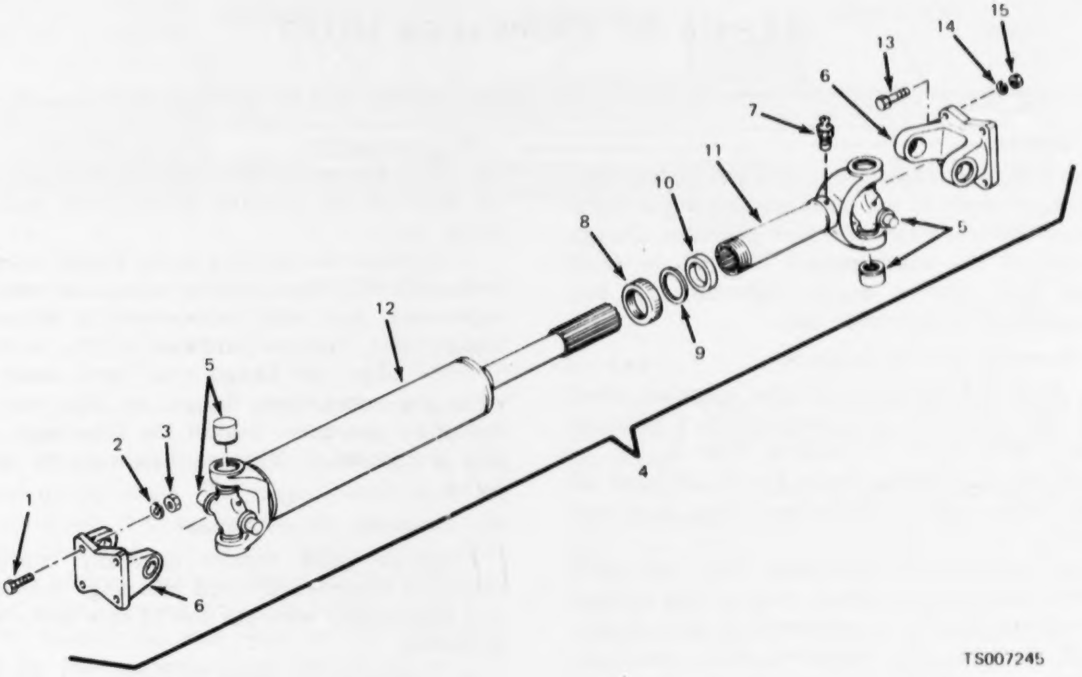
(2) Align the parking brake flange yoke (slip yoke end) with the mounting holes, and install the capscrews, nuts and lockwashers to secure the flange yoke. Tighten hardware to 40 - 44 ft/lbs.

(3) Align the flange yoke (stub shaft end) with the companion flange on the rear axle reduction gearcase. Install the capscrews, nuts and lockwashers. Tighten hardware to 40—44 ft/lbs.

8-3. Propeller Shaft Repair

Propeller shaft repairs generally consist of complete disassembly and cleaning, inspection, and reassembly with the use of new parts where indicated.

a. Disassembly. Refer to figure 8-1 for parts identification, and proceed as follows:



1. Screw
2. Lockwasher
3. Nut
4. Shaft assembly
5. Cross and bearings
6. Flange yoke
7. Lubrication fitting
8. Dust cap
9. Steel washer
10. Cork washer
11. Sleeve yoke
12. Stub yoke
13. Screw
14. Lockwasher
15. Nut

Figure 8-1. Propeller Shaft Assembly.

(1) Remove snap rings by pinching the ends together with a pair of needle nose pliers. If a ring does not readily free from the groove, tap the end of the bearing cap lightly to relieve the pressure against the ring.

(2) Remove needle bearings (5) by driving on the end of one bearing cap until the opposite bearing cap is forced out of the yoke. Turn the joint over and tap on the end of the journal cross until the opposite bearing cap is free. Use a wooden dowel, of a diameter about 1/32 to 1/16 smaller than the hole in the yoke, as a drift.

(3) Separate journal cross and yokes by sliding journal to the side of the yoke, and tilting over the top of the yoke lug.

(4) Free slip yoke (11) and stub yoke (12) by unscrewing dust cap (8) and pulling apart.

b. Cleaning, Inspection, and Repair.

(1) Clean all parts in a bath of solvent, Federal Specification P-D-680. Allow the parts to remain in the solvent for some time to loosen up any particles of grease or foreign matter. Remove any burrs or rough spots from any machined surfaces.

(2) Do not disassemble the needle bearings. Clean with short stiff brush and blow out with compressed air. Work a small quantity of lubricant (140 S. A. E. oil) into each bearing cap and turn the needle bearing on the trunnion to check wear. Replace if worn.

(3) Because worn needle bearings used with a journal cross or new needle bearings used with a worn journal cross will wear more rapidly, making another replacement necessary in a short time, always replace the journal cross and four needle bearing caps as a unit. These parts are furnished together in the service assembly. (See TM 10-3930-633-34P).

c. Assembly. Refer to figure 8-1 and assemble the propeller shaft as follows:

(1) Lubricate the splines on the stub shaft with clean engine oil (OE) and place dust cap (8), steel washer (9) and cork washer (10) over the stub spline (11).

(2) Slide stub yoke (12) into slip yoke (11), being very careful to make certain the arrows stamped on the slip yoke and stub yoke are exactly in line. Tighten dust cap on slip yoke.

CAUTION

Failure to align arrows will cause excessive shaft vibration and rapid failure.

(3) Work the bearing journal into place in each yoke, and install bearings (5) through the eyes of each yoke.

(4) Install snap rings to secure bearings in yoke.

(5) Lubricate the shaft assembly by applying proper lubricant (LO 10-3930-633-12) with a grease gun to the fittings on each bearing journal and on the slip yoke. Grease should be added until it begins to extrude through the bearing and slip yoke seals.

(6) Check the assembly before installation for the following conditions:

(a) No damage or dents on propeller shaft tubing which could cause unbalance. If the dents are severe enough they can weaken the tube and a failure might occur under torque load.

(b) Splines should slide freely with slight drag from spline seal.

(c) Bearings should flex and be free from excessive bind. A slight drag is the most desirable condition on a new universal joint. This drag is from the bearing seals. When rotating, yoke lug deflections cause some additional clearance. Excessive looseness is not desirable due to the resulting unbalance.

(d) Mounting flanges and pilots should be free from burrs and paint which would not allow proper seating at assembly.

CHAPTER 9

REPAIR OF WHEELS AND BRAKES

Section I. WHEELS AND TIRES

9-1. General

The rear wheels of the tractor are a one-piece welded steel disc-type wheel with split lock rings, sized for 6:50x16 inch tires. Normal inflation pressure is 45 lbs. The front wheels are two-piece split type, sized for 6:50x10 inch tires. Normal inflation pressure is 100 lbs. Both front and rear tires are 6 ply, tube type.

9-2. Replacing Tires and Tubes

WARNING

Always deflate tires completely before attempting demounting. Remove valve core to insure complete bleed-off of any residual pressure.

a. Demounting Rear Tires.

(1) Jack up vehicle so that tire is clear of the floor.

(2) Deflate tire completely, and remove valve core.

(3) Remove wheel mounting nuts and lift wheel and tire off vehicle.

(4) Lay wheel on the floor with the lock ring side facing up.

(5) Using the curved end of one rim tool, and the hooked end of another, pry the tire bead downward, away from lock ring, using downward pressure on rim tools.

(6) Continue prying operation completely around the tire until the bead is completely unseated from the lock ring.

(7) To disengage lock ring from the gutter, insert one rim tool in the tool slot of the lock ring, and pry ring upward and outward.

(8) Continue in this manner progressively around rim until ring is completely removed. Then remove tire and tube from wheel.

b. Mounting Rear Tires.

(1) Place tube inside tire, and lay tire over wheel (lock ring side up) so that tire valve stem is in line with the hole in the wheel.

(2) Pull the valve stem through the hole in the wheel.

(3) Lay lock ring over the wheel and step on the ring at the split, to force one end down into its seat.

(4) Continue around the lock ring using foot pressure to force the ring into place. Make absolutely certain the ring is properly seated all the way around.

(5) Inflate tire to about 10 PSI, then deflate and inflate again to 45 PSI. Use a safety cage when inflating tire if one is available. Otherwise, lay tire on floor with lock ring side down, or inflate with lock ring side away from operator.

(6) Mount wheel and tire assembly on vehicle, and torque wheel nuts to 125—140 ft/lbs.

c. Demounting Front Tires.

(1) Raise or jack up vehicle until the tire clears the floor. Deflate tire completely and remove valve core.

(2) Refer to figure 9-1 and remove the nuts on the INNER BOLT CIRCLE ONLY.

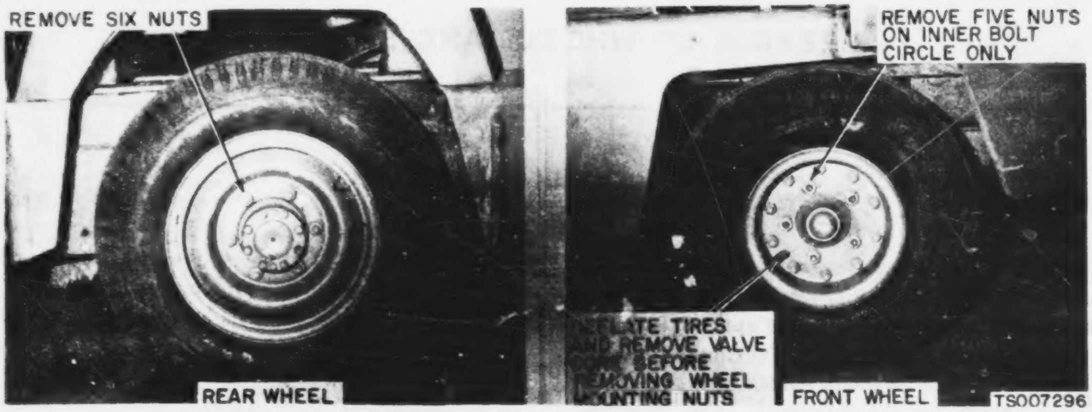

REMOVE SIX NUTS
REAR WHEEL
REMOVE FIVE NUTS ON INNER BOLT CIRCLE ONLY
DEFLATE TIRES AND REMOVE VALVE CORE BEFORE REMOVING WHEEL MOUNTING NUTS
FRONT WHEEL
TS007296

Figure 9-1. Wheel Removal.

(3) Lift the wheel and tire assembly off the vehicle.

(4) Remove the ten capscrews, nuts and washers securing the wheel halves, and separate the wheel halves, tire, tube and flap.

d. Mounting Front Tires.

(1) Position tube inside tire, lay tire over inside wheel half.

(2) Position outside wheel half so that tire valve may be pulled through hole in wheel. Make certain that tube flap is in place.

(3) Insert the ten capscrews from inside wheel half so they protrude through the outside wheel half. Install nuts and lockwashers over all ten screws. Torque screws to 60—75 ft/lbs.

(4) Inflate the tire to 100 PSI in a safety cage. Mount wheel on front axle. Torque wheel nuts to 125—140 ft/lbs.

9-3. Tire Repair

a. Once removed, inspect tires carefully for cuts, bruises, punctures, and imbedded objects. Clean out all rocks and foreign objects lodged in the tread. Punctures in the tire can be plugged, or repaired by hot or cold patch methods. Tubes are repaired by hot or cold patch methods, following the instructions furnished with the patch material.

b. Check tire wear pattern carefully for any uneven wear patterns. Type of uneven wear and their causes are: wear in center of tread (over-inflation), wear on both edges of tread (under inflation), wear on one side or "feathering" of tread (out of alignment), and "cupping" or flat spotting (out of balance).

9-4. Wheel Repair

Check wheels carefully for bent condition in rim or flange area. Straighten as required. Keep wheels clean, especially at the wheel to drum mounting flange, and bead seating area. Wheels evidencing cracks between mounting holes, or anywhere in the rim area, must be replaced.

Section II. BRAKE SYSTEM

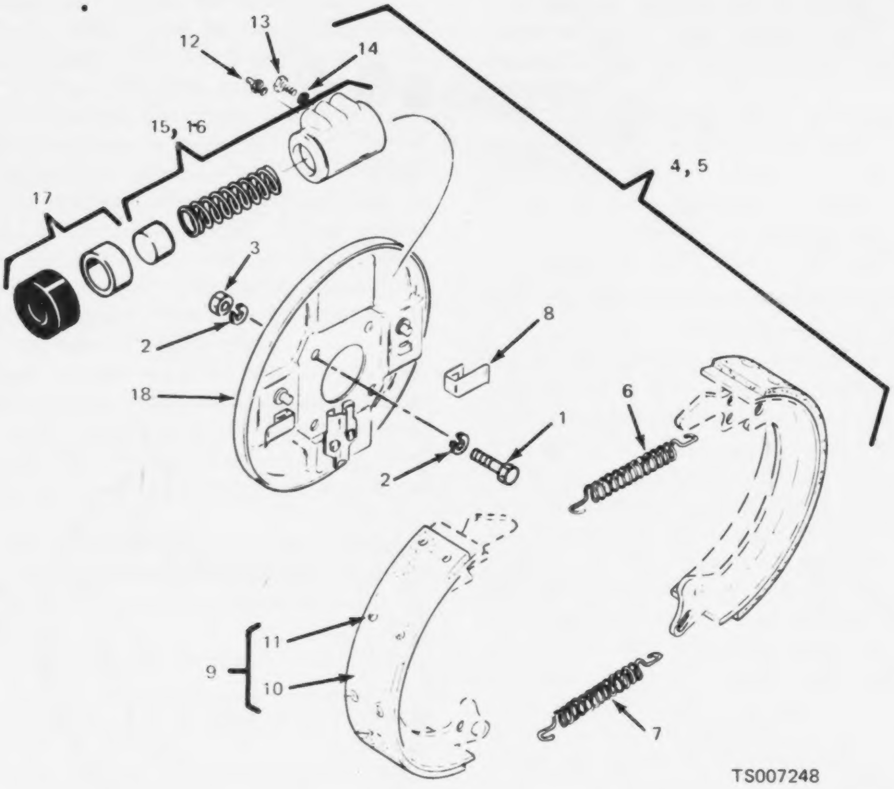
9-5. General

The four wheel hydraulic brakes are of the internal expanding shoe type. The brake system incorporates a tandem master cylinder where the front axle brakes and the rear axle brakes are on separate hydraulic circuits. This arrangement prevents complete loss of braking action in cases of failure at some point in the system. The operator's pedal effort is assisted by a vacuum booster on the master cylinder pushrod. Engine vacuum is used to operate the booster. Each brake assembly provides a means for mechanical adjustment of lining-to-drum clearance.

9-6. Brake Assembly Repairs

Repairs to the brake assemblies consist of reconditioning the brake drums by turning on a lathe to true-up the lining contact surface, and the replacement of worn or defective parts through the installation of repair kit parts and shoe and lining sets. Refer to TM 10-3930-633-12 for procedures concerning brake adjustment and removal of wheels and brake drums.

a. Disassembly(Front Brakes). Refer to figure 9-2 for parts identification and proceed as follows:



1. Screw
2. Lockwasher
3. Hex nut
4. Brake assembly RH
5. Brake assembly LH
6. Return spring
7. Return spring
8. Clip
9. Shoe and lining
10. Lining
11. Rivets
12. Bleeder screw
13. Screw
14. Lockwasher
15. Wheel cylinder RH
16. Wheel cylinder LH
17. Repair kit
18. Backing plate

Figure 9-2. Front Brake Assembly.

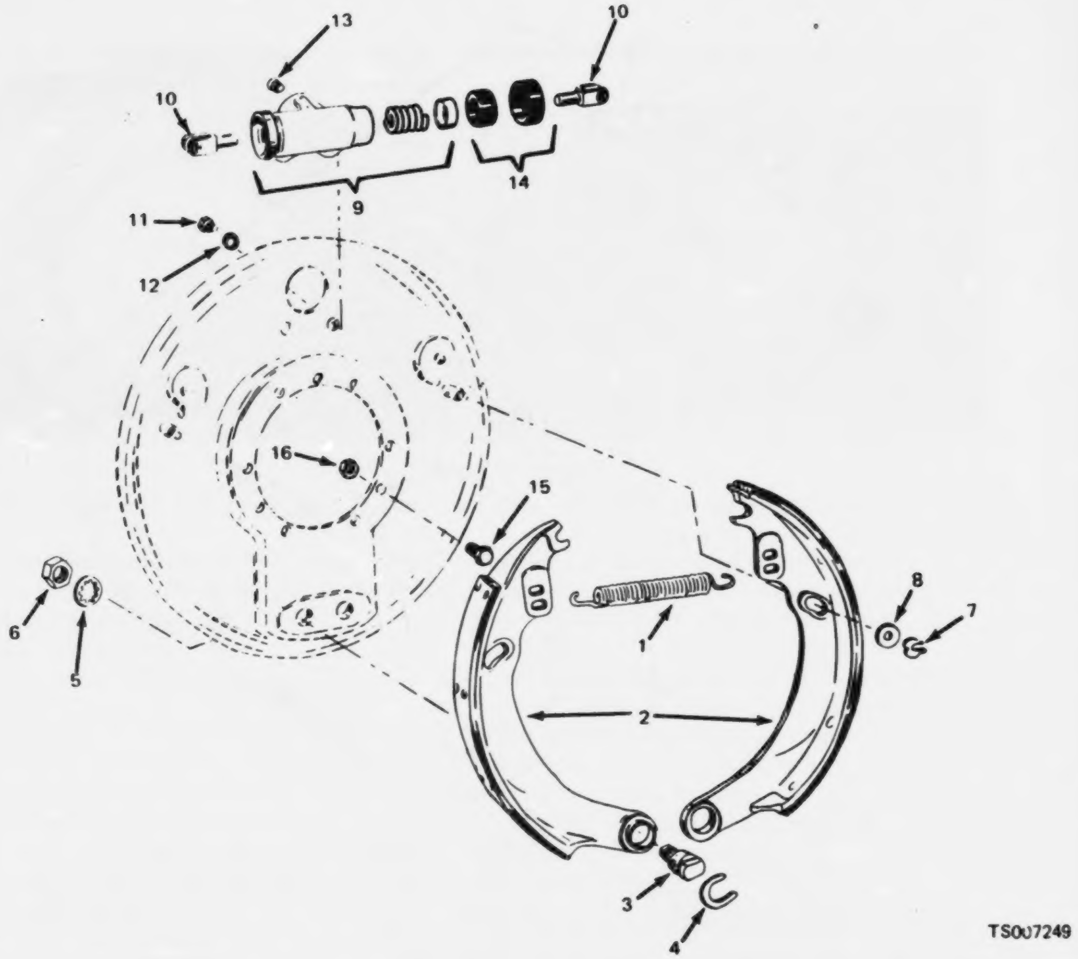
(1) After removal of brake drum, unhook return springs (6) and (7).

(2) Remove shoe and lining assemblies (9) and clips (8).

(3) Remove screws (13) and lockwashers (14) and lift off wheel cylinder assembly (15). Remove bleeder screw (12).

(4) Backing plate (18) is not removed from axle unless damaged.

b. Disassembly (*Rear Brakes*). Refer to figure 9-3 for parts identification and proceed as follows:



1. Return spring
2. Shoe and lining
3. Anchor pin
4. Ring
5. Lockwasher
6. Hex nut
7. Cotter pin
8. Washer
9. Wheel cylinder assembly
10. Pushrod
11. Capscrew
12. Lockwasher
13. Bleeder screw
14. Cylinder kit
15. Capscrew
16. Hex nut

Figure 9-3. Rear Brake Assembly.

(1) Unhook return spring (1). Pull off clip (7) and washer (8) from guide pin.

(2) Pull off ring (4) from each anchor pin (3), and remove the shoe and lining assemblies (2).

(3) Remove cylinder pushrods (10). Remove capscrews (11) and lockwashers (12), and lift off wheel cylinder assembly (9). Remove bleeder screw (13).

(4) Remove nut (6) and lockwasher (5) to remove anchor pin (3).

(5) Backing plate is not to be removed from axle unless damaged.

c. *Cleaning, Inspection, and Repair.*

(1) Clean cylinder castings thoroughly with solvent, Federal Specification P-D-680.

(2) After cleaning, hold the cylinder casting up to a strong light and sight through the cylinder bore. Any blemishes such as pitting, visible wear patterns, etc., will necessitate unit replacement.

(3) A hone may be used to "clean-up" the cylinder, provided its use does not materially increase the size of the bore.

(4) Cylinder diameter must not exceed the nominal dimension by more than 0.007 inch. This figure can be checked with a "GO-NO GO" type gage or by inserting a piston into the cylinder and checking clearance with a wire gage.

(5) If mineral oil is present in the system, the

rubber cups will be enlarged and very soft. These cannot be used and should be discarded.

(6) Cylinder walls must be smooth and not pitted or scratched and be free from burrs. Remove light pits, scratches and burrs with a hone. If cylinder does not clean up with light honing, cylinder must be replaced.

(7) Occasionally grease retainers become worn, allowing lubricant from wheel bearings to leak through in the brake drum. When grease comes into contact with end closures, they become soft and enlarged, preventing them from protecting the cylinder from foreign matter. If this occurs, replace defective parts.

(8) Inspect anchor pins for rust, or scoring. Clean all dirt and rust from anchor pins and coat pins lightly with "Lubriplate 110" or equivalent.

(9) Check return springs, washers and retaining clips for wear or corrosion and replace as required.

(10) Check brake shoes for wear and grease or oil soaking. Replace shoes which are worn to within 1/32 of the rivet heads or shoe surface.

d. Reassembly.

(1) Reassemble front brakes in accordance with figure 9-2.

(2) Reassemble rear brakes in accordance with figure 9-3.

(3) Always install wheel cylinder spring, piston and cups, and cylinder boots, and mount the wheel cylinder to the backing plate before installing shoe and lining assemblies.

(4) After reassembly of brakes, and installation of brake drums, bleed and adjust brakes as outlined in TM 10-3930-633-12.

9-7. Brake Drum Refinishing

a. Minor scores on a brake drum can be removed with fine emery cloth, provided the emery is thoroughly cleaned off the drum after the operation.

b. A badly scored, rough, or out-of-round drum should be ground or turned on a drum lathe. Do not remove any more material from the drum than is necessary to provide a smooth surface for the brake shoe contact. In no case should the drums be turned to more than 0.060 inch oversize.

9-8. Vacuum Power Unit Decription

a. General. The vacuum power unit (fig. 9-4) is a self-contained vacuum-hydraulic unit for power braking that uses engine manifold vacuum and atmospheric pressure for its power. It permits the use of a low brake pedal, and provides reduced pedal effort, compared to the conventional (non-power) hydraulic braking system. The dual-system hydraulic section of the Master-Vac is similar to the manually operated dual-system master cylinder except that the hydraulic pushrod is a part of the power section. The separate hydraulic systems provided by this master cylinder prevent a hydraulic failure in either system from affecting the other system. If a hydraulic failure does occur, the driver is aware of it, either immediately when it happens, or on the next brake application, because of the increased pedal travel required to get braking action. In addition, vehicle deceleration with only the front or rear brakes functioning will, usually, be less effective, requiring either greater pedal effort for the same stopping distance or greater distance.

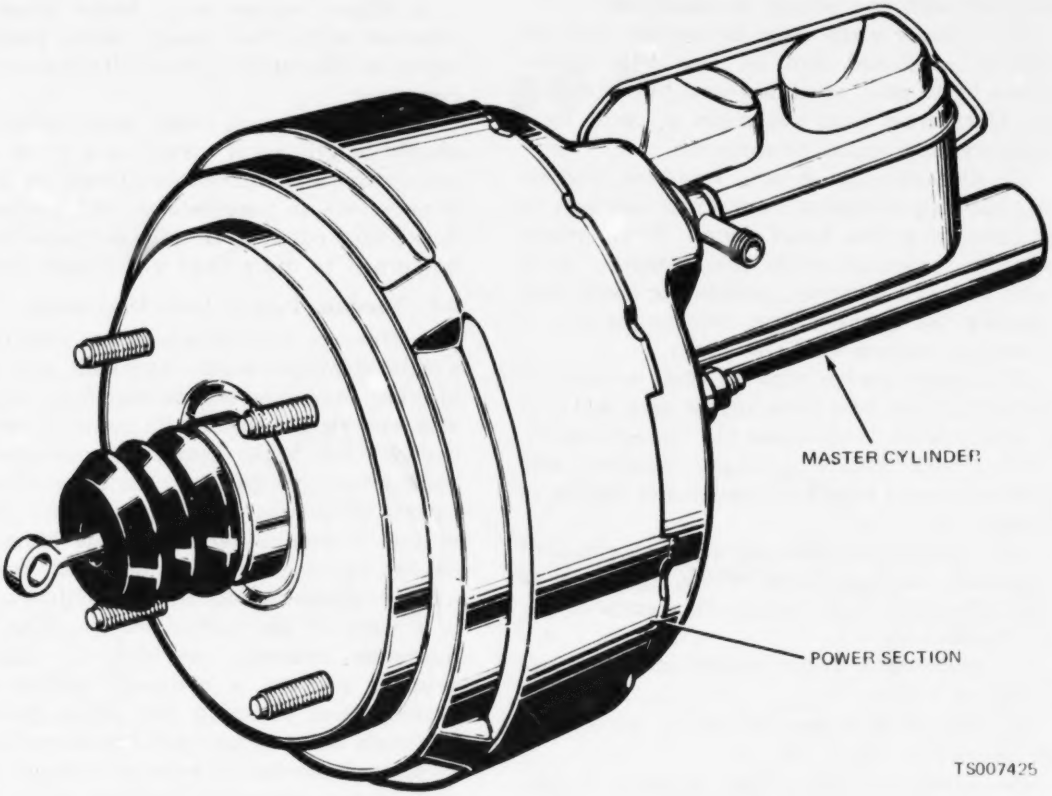

MASTER CYLINDER
POWER SECTION
TS007425

Figure 9-4. Vacuum Power Unit.

b. Construction. The vacuum power unit consists of three basic elements which are:

(1) A vacuum power chamber (fig. 9-5) consists of a front and rear shell, a center plate, a front and rear diaphragm and plate assembly, a hydraulic pushrod and a vacuum diaphragm and plate return spring.

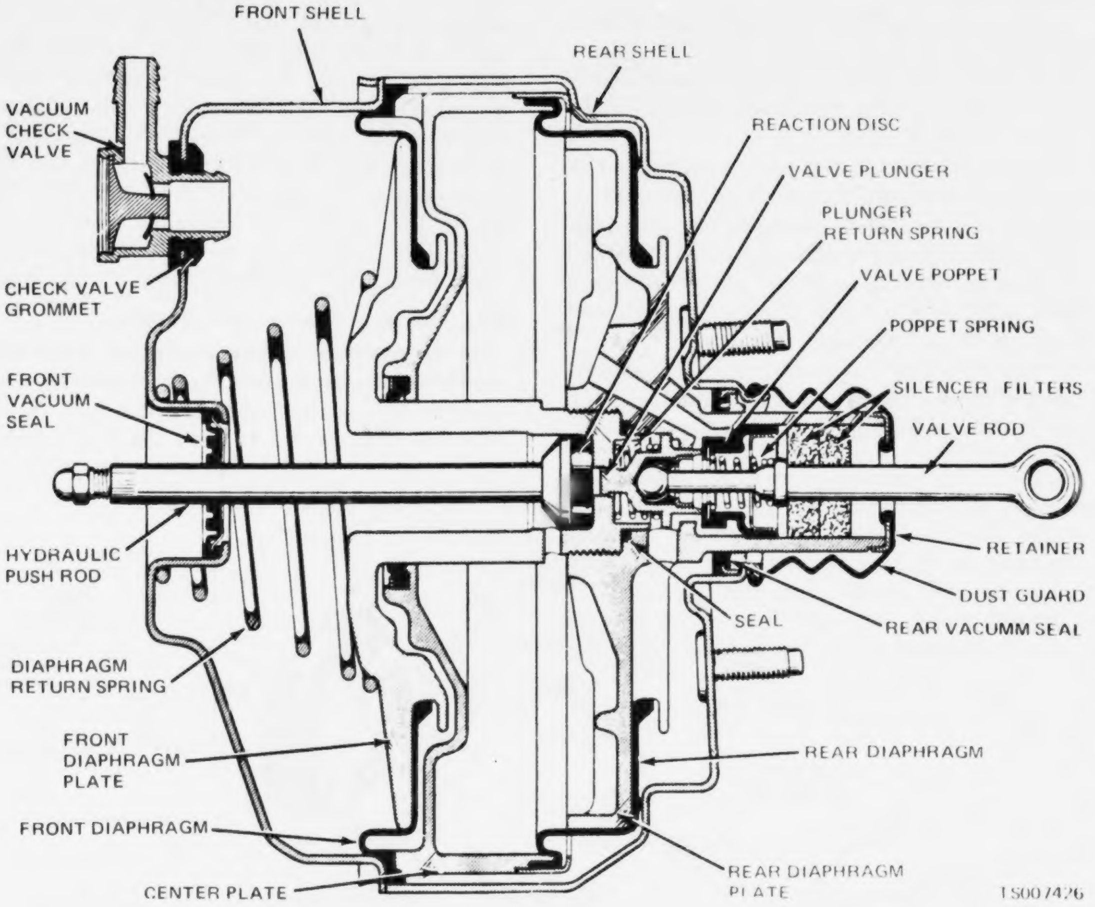

FRONT SHELL
REAR SHELL
VACUUM CHECK VALVE
REACTION DISC
VALVE PLUNGER
PLUNGER RETURN SPRING
VALVE POPPET
CHECK VALVE GROMMET
POPPET SPRING
FRONT VACUUM SEAL
SILENCER FILTERS
VALVE ROD
HYDRAULIC PUSH ROD
RETAINER
DUST GUARD
SEAL
REAR VACUMM SEAL
DIAPHRAGM RETURN SPRING
FRONT DIAPHRAGM PLATE
REAR DIAPHRAGM
FRONT DIAPHRAGM
REAR DIAPHRAGM PLATE
CENTER PLATE
TS007426

Figure 9-5. Vacuum Power Unit Cross Section.

(2) A manually actuated control valve integral with the vacuum power diaphragm and plate hubs that controls the degree of power brake application or release in accordance with the foot pressure applied to the valve operating rod through the brake pedal linkage. The control valve consists of a single poppet with an atmospheric port and a vacuum port. The vacuum port seat is formed in the hub of the rear diaphragm plate. The atmospheric port seat is part of the valve plunger which moves within the valve housing hub of the diaphragm plates.

(3) A hydraulic dual-system master cylinder that provides two hydraulic fluid reservoirs, cast integrally with and connected to the bore through separate sets of compensating and fluid inlet (by-pass) ports. Both reservoirs are sealed by a rubber diaphragm inside the baletype cover. A primary piston assembly with secondary seal, primary cup, protector, spring, screw and spacer; a secondary piston with two "back-to-back" secondary seals, primary cup, protector, spring and spring retainer; a piston stop screw and O-ring seal; and two separate check valves (residual pressure), springs and tube seat retainers mounted in the two outlet ports provide the operating components of the two separate hydraulic systems. See TM 10-3930-633-12 for complete description and repair procedures on the master cylinder.

c. Operation.

(1) The vacuum power diaphragm plates and parts that make up the valve assembly are connected to the brake pedal through the valve operating rod. The valve operating rod is connected to the valve plunger which moves within the hub of the power diaphragm and plate assembly. A valve return spring returns the valve plunger and valve rod to the released position when the brake pedal is released. The valve

poppet is of the flexible rubber type and is supported by the valve body hub of the rear diaphragm plate.

(2) In the released position, the poppet return spring holds the poppet against the atmospheric port seat (valve plunger). A special type of seal is used to seal the opening between the valve body sleeve and the rear shell.

(3) Vacuum is supplied to the power brake unit through a vacuum check valve mounted in the front shell. Air for operation is admitted through silencer-filters within the valve housing. At its front end, the power section incorporates another special seal to close the opening between the front shell and hydraulic pushrod.

(4) The hydraulic pushrod is the link between the vacuum power diaphragm and plate assembly and the hydraulic pistons in the master cylinder. The center plate, located between the two diaphragms, divides the power unit into four chambers. A long, threaded hub on the front plate slides through the center hole in the center plate and is screwed into the hub of the rear plate to maintain a set separation between the two diaphragms as the front and rear plates and diaphragms move backward and forward. This front plate hub is sealed by a vacuum seal that is permanently installed in the stationary center plate. Two drilled air passages intersect in the mounting flange of the master cylinder to provide "free breathing" for this cavity during braking.

9-9. Vacuum Power Unit Repair

a. Disassembly. Refer to figure 9-6 for parts identification and proceed as follows:

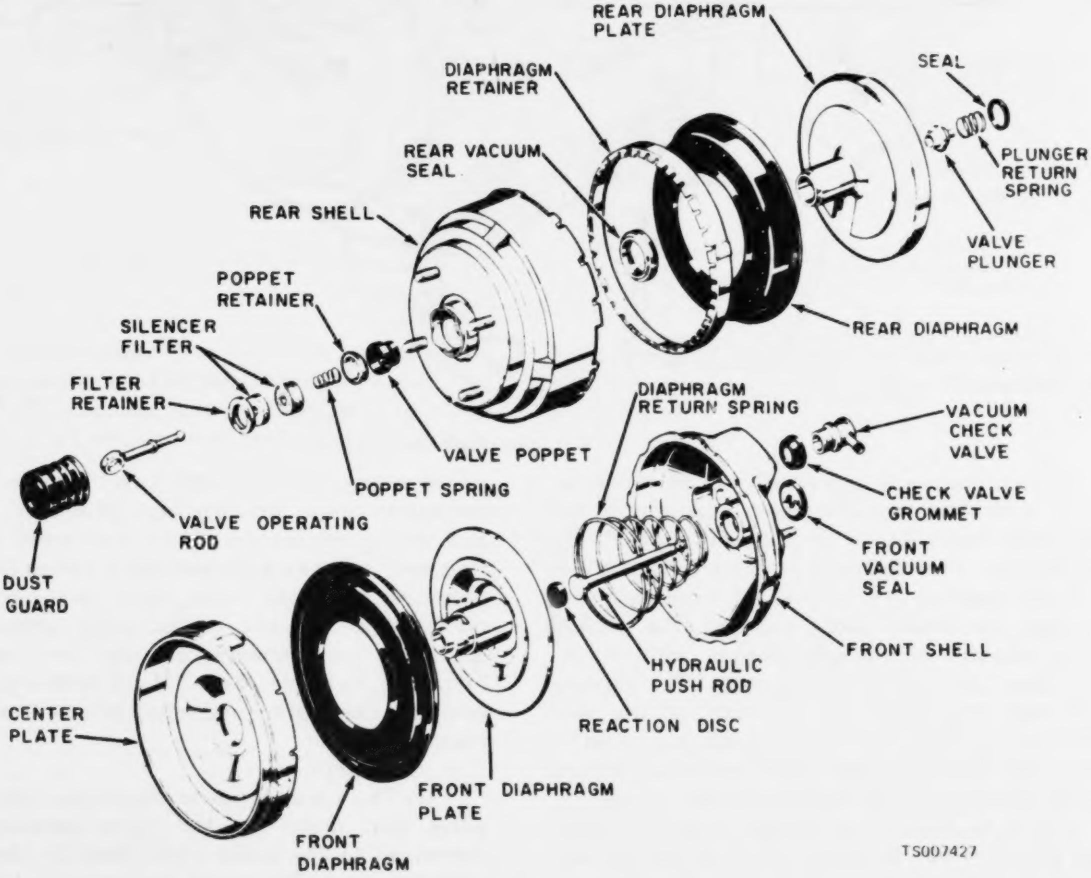

REAR DIAPHRAGM PLATE
SEAL
DIAPHRAGM RETAINER
REAR VACUUM SEAL
PLUNGER RETURN SPRING
REAR SHELL
VALVE PLUNGER
POPPET RETAINER
REAR DIAPHRAGM
SILENCER FILTER
FILTER RETAINER
DIAPHRAGM RETURN SPRING
VACUUM CHECK VALVE
VALVE POPPET
POPPET SPRING
CHECK VALVE GROMMET
VALVE OPERATING ROD
FRONT VACUUM SEAL
DUST GUARD
FRONT SHELL
HYDRAULIC PUSH ROD
CENTER PLATE
REACTION DISC
FRONT DIAPHRAGM PLATE
FRONT DIAPHRAGM
TS007427

Figure 9-6. Vacuum Power Unit Exploded View.

(1) Scribe across the flanges of both shells and the master cylinder to provide a guide mark for assembly. Remove master cylinder attaching nuts and lockwashers and set master cylinder aside.

NOTE

Do not disturb adjustment screw on end of hydraulic pushrod.

(2) Remove hydraulic pushrod from front shell of power section and then remove front vacuum seal from pushrod. Wet valve rod eye and small diameter of dust guard with alcohol and then remove dust guard from valve rod and hub of rear shell. Pull vacuum check valve straight out of grommet in front shell.

(3) Remove air filter-silencers from valve hub. With operating rod in vertical position, squirt alcohol down rod to wet rubber grommet in valve plunger at ball end of valve rod. Clamp valve in soft-jawed vise. Leave just enough space between steel retainer on plastic valve hub and side of vise jaw for two medium sized open end wrenches. Use wrench nearest vise as a pry to force valve plunger (and power section) off ball end of valve rod. See figure 9-7.

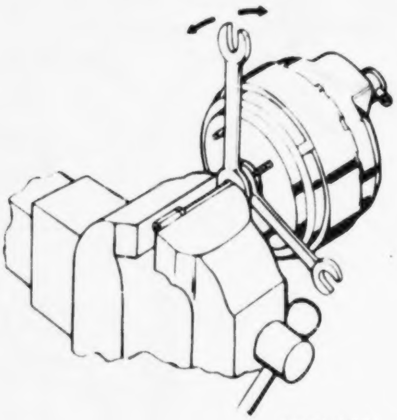


Figure 9-7. Removing Valve Rod.

CAUTION

When separating valve rod from plunger, hold power section to prevent it from falling to the floor.

(4) Use care when prying with wrenches to avoid damage to plastic valve hub. Remove valve rod from vise. Carefully pry retainer off end of valve hub. Do not chip or crack plastic. Remove valve return spring, poppet retainer and poppet.

(5) Make up a removal tool as shown in figure 9-8. Clamp base of special tool in vise as shown in figure 9-8, and insert rear shell studs in matching holes in base (three or four studs as required). Place flat bar wrench over studs of front shell and align top clamp bar with base. Attach hook bolts of top clamp bar to holes at opposite ends of base. Tighten T-handle center bolt just enough to compress shells and free twelve lanced locks around shell edges. Turn flat bar wrench *counterclockwise* until cut-outs on front shell are aligned with locks on rear shell. Unscrew center bolt. Shells should begin to separate as load on center bolt is released. If shells do not separate, check cut-out and lock alignment and then tap shell flange lightly with soft hammer to break bond between diaphragm and shells.

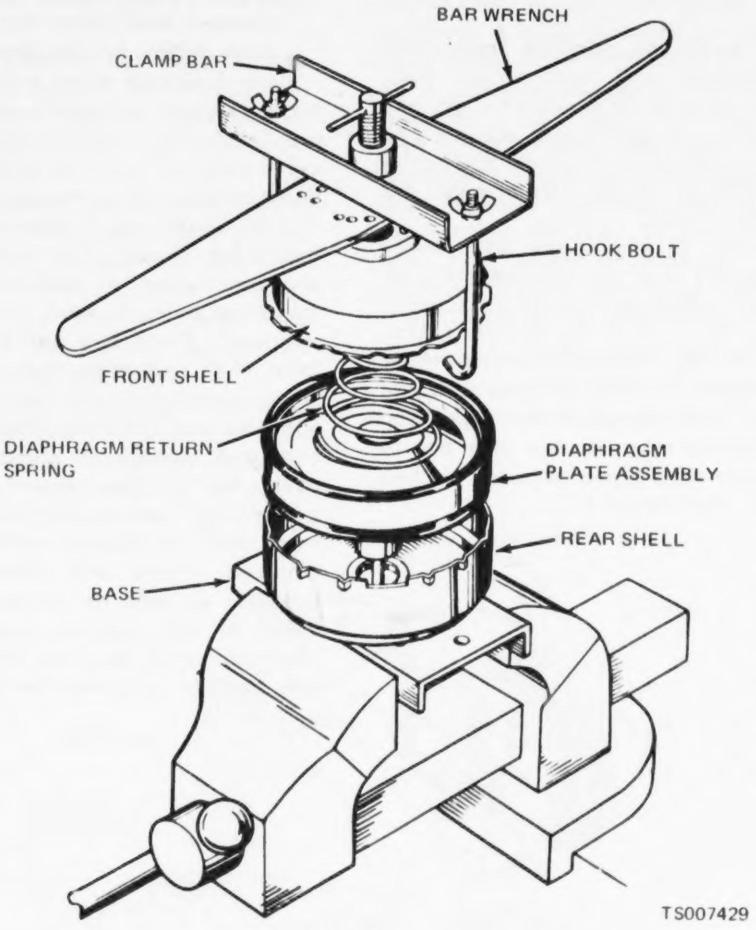


Figure 9-8. Separating Front and Rear Shells.

WARNING

Press down firmly on top clamp bar while removing hook bolts from base to prevent internal spring force from causing shells to fly apart. Remove hook bolts, top clamp bar, flat bar wrench, front shell and return spring. Lift power diaphragm and plate assembly from rear shell and remove rear shell from fixture base.

(6) Wet rear diaphragm spring retainer with alcohol and remove, using fingers only. Remove rear diaphragm from rear plate. Set 1-1/16" hex bar stock 2" long in a vise. Set diaphragm and plate assembly on hex stock with hex opening in front plate seated on bar. Twist rear plate counterclockwise, using hard pressure only on atmospheric pressure channel or outer edge of plate.

(7) After plates have been loosened, remove assembly from vise and complete disassembly on bench, front end down. Unscrew rear plate completely and carefully lift it off front plate hub, grasping valve plunger and spring with other hand and removing them from bore of front plate hub. Remove square ring seal from shoulder of rear plate.

NOTE

Seal may stick to shoulder of front plate.

(8) Using a small rod or screwdriver through center bore of front plate, push out reaction disc. Loosen front diaphragm from center plate and slide center plate carefully off front plate hub.

CAUTION

DO NOT damage or remove seal assembly from hub of center plate.

(9) Remove front diaphragm from front plate.

(10) Place shell on work bench, studs up, and drive seal out of shell.

NOTE

DO NOT remove seal unless a new seal is available.

b. Cleaning.

(1) After disassembly, all metal parts should be cleaned in solvent, Federal Specification P-D-680. Plastic parts and rubber parts should be cleaned ONLY by wiping with a cloth moistened in the same type solvent. Care should be taken to prevent chipping or cracking of plastic parts. Replace all rubber parts, except power diaphragms. After parts have been cleaned, use clean (filtered) dry compressed air to blow dirt and solvent out of recesses and internal passages.

c. Inspection. Inspect all parts for damage or excessive wear. The power diaphragms must be free of kinks, cracks and tears. Replace any damaged, worn or chipped parts.

d. Assembly.

(1) If vacuum seal and bearing was removed from rear shell, press new seal into shell cavity, plastic side firs (fig. 9-9), until flat rubber surface is about 5/16" below flat inside shell surface (.305" minimum).

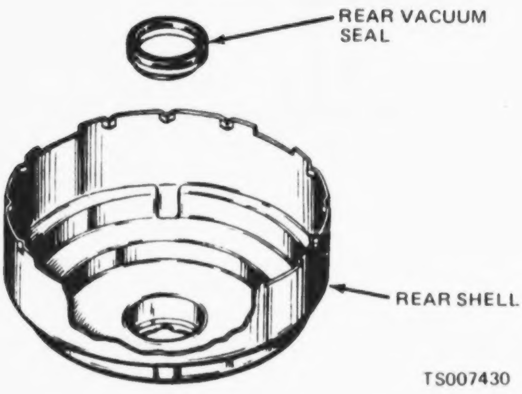


Figure 9-9. Installing Vacuum Seal.

(2) Install front diaphragm on front plate. Apply a light coat of hydraulic brake fluid to outside surface of front plate hub and liberally to the seal in the center plate hub. Carefully guide center plate and seal assembly, seal side first, onto front plate hub. Apply hydraulic brake fluid lightly to the front and rear bearing surfaces of the valve plunger, being careful not to get any lubricant on the rubber grommet inside the plunger. Assemble valve plunger return spring on valve plunger as shown in figure 9-6, and set spring and plunger in recess of front plate hub, grommet side up. Place vacuum seal firmly against shoulder on outside of front plate hub. Set rear plate, threaded bore down, over valve plunger and, using hands only, screw rear plate onto front plate hub. To tighten plates, place 1-1/16" hex bar stock in vise and set plate assembly, front plate down, on hex bar. Using air channel slot or rear plate edges, hand torque plates to 120—180 in./lbs. Remove plate assembly from vise. Install rear diaphragm on rear plate and over lip of center plate. Assemble diaphragm spring retainer over rear diaphragm and lip of center plate. Using fingers only, press retainer onto center plate until it seats against shoulder of center plate.

(3) Apply talcum powder to inside wall of rear shell. Apply hydraulic brake fluid (or equivalent) liberally to bearing seal in rear shell. Apply hydraulic brake fluid (or equivalent) liberally to cutouts around edge of front shell. Clamp fixture base in vise and insert rear shell studs through matching holes in base. When assembling the plate and diaphragm assembly in the rear shell, the lugs on the center plate must be aligned between the lances on the rear shell. Carefully guide valve housing sleeve through bearing seal in rear shell keeping center plate and diaphragms in correct alignment. Work outer rim of front diaphragm into rear shell so that outer rim is under each of the retaining lances on the rear shell. Place large diameter end of diaphragm return spring over front plate hub and position front shell on spring so that scribe marks on front and rear shells will be aligned when shells are twist-locked in place. Place bar wrench over studs of front shell and then attach clamp bar with hook bolts to base. Before tightening center bolt, make certain cut-outs on front shell are aligned with locks on rear shell. Guide rim of diaphragm into front shell. Tighten center bolt until edge of front shell will clear lances on rear shell. Twist front shell *clockwise* in relation to the rear shell until stop is contacted. Remove tools from power cylinder.

(4) Apply hydraulic brake fluid liberally to entire surface of reaction disc and to piston end of hydraulic pushrod. Place reaction disc on piston end of pushrod. Apply Bendix Type "O" Lubricant (or equivalent) sparingly on shaft of pushrod, keeping lubricant away from adjusting screw end of pushrod.

CAUTION

Lubricant must not be allowed to get on adjusting screw or threads.

(5) Insert pushrod with reaction disc stuck to it into reaction disc hub of front plate. Twist and press on pushrod to make certain disc is seated firmly. Assemble seal, support plate side

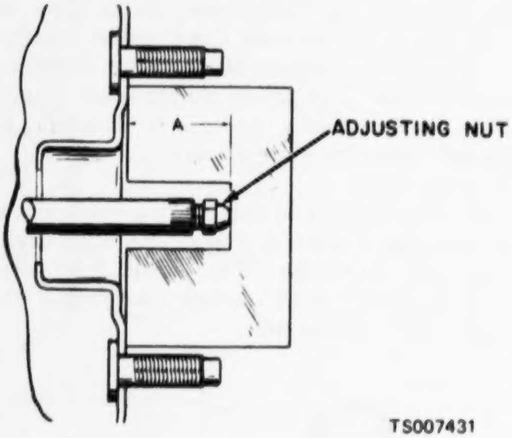
first, over adjusting screw end of pushrod. Press seal into cavity in front shell until seal bottoms. If vacuum check valve was removed, wet new grommet in alcohol and press grommet into front shell, beveled side first. Make certain that grommet is seated in shell. Wet shoulder of check valve in alcohol and assemble check valve in grommet. Press check valve into grommet until entire flange of check valve bears against grommet.

(6) Wet poppet valve in alcohol and assemble poppet in valve housing, small diameter end of poppet first; wet poppet retainer in alcohol and assemble in housing with flange out. Press in against retainer to make certain that shoulder of retainer is positioned inside poppet. Assemble retainer, valve silencers and filters and valve return spring over ball end of operating rod in that order. Wet rubber grommet in valve plunger and ball end of operating rod with alcohol. Guide spring, filters and silencers into valve housing and assemble ball end of operating rod in valve plunger grommet. Tap end of rod with soft hammer to lock ball end in grommet. Press filters into position inside plastic housing and assemble metal retainer on end of housing, being careful not to chip plastic.

(7) Wet small diameter of dust guard with alcohol and assemble dust guard over end of operating rod, using care to prevent tearing guard. Press guard against valve housing and seat large end of guard over flange of rear shell.

(8) Unit is now ready for assembly with master cylinder (TM 10-3930-633-12). Check pushrod adjustment as shown in figure 9-10. Distance "A" should be 0.880-0.995 inches. Adjust this distance by threading nut in or out in the end of pushrod.

(9) Installation of the unit is covered in Chapter 2, Section IV.



TS007431

Figure 9-10. Adjusting Pushrod.

CHAPTER 10

REPAIR OF REAR AXLE AND SPRINGS

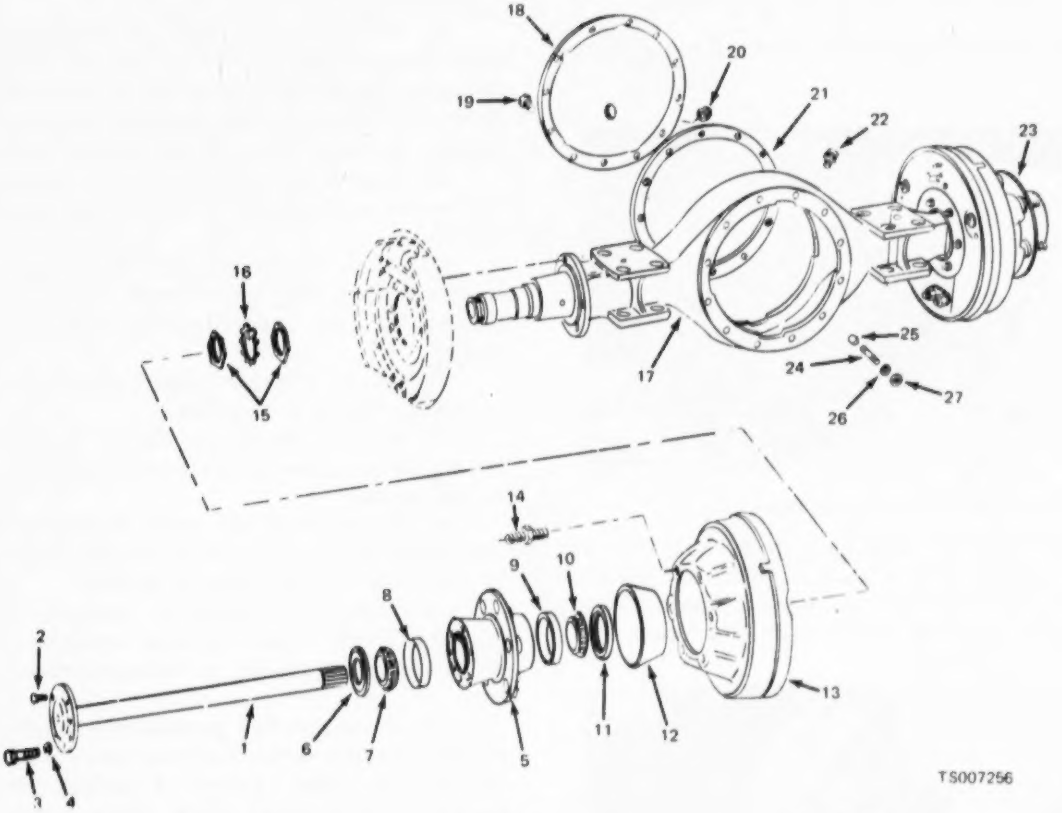
10-1. General

The rear axle is a double reduction spiral bevel pinion type, with full-floating axle shafts. The double reduction is provided by means of a drop gearcase mounted on the differential carrier input shaft. The axle housing is of cast steel for maximum strength.

10-2. Rear Axle Repair

a. Removal. Refer to Chapter 2, Section IV, for complete removal procedures covering the rear axle and springs.

b. Disassembly. Refer to figure 10-1 for parts identification and proceed as follows:



1. Axle shaft
2. Puller screw
3. Stud
4. Lockwasher
5. Hub
6. Seal, outer
7. Cone
8. Cup
9. Cup
10. Cone
11. Seal
12. Slinger
13. Brake drum
14. Stud
15. Nut
16. Lock
17. Housing
18. Cover
19. Capscrew
20. Filler plug
21. Gasket
22. Vent
23. Stud
24. Stud
25. Dowel
26. Washer
27. Nut

Figure 10-1. Rear Axle Assembly.

(1) Remove axle shaft nuts and lockwashers (4) on both sides of axle. Using puller screws in two holes provided, loosen axle shaft flange as shown in figure 10-2.

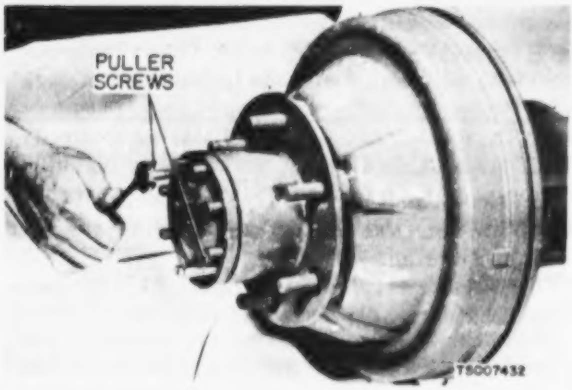


Figure 10-2. Loosening Axle Shaft Flange.

(2) Remove axle shaft as shown in figure 10-3.

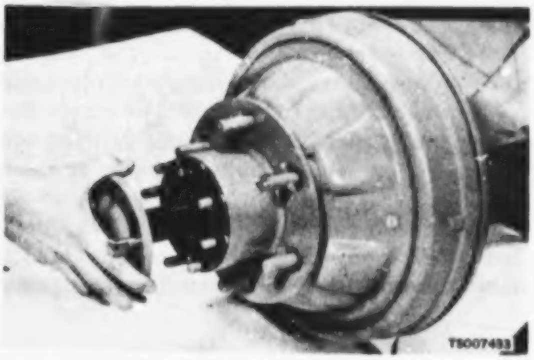


Figure 10-3. Removing Axle Shaft.

(3) Bend up tang on bearing lock exposed after removal of axle shaft. Loosen and remove bearing nuts and nut lock. Remove bearing cone. Pull off hub and drum assembly. See figure 10-4.

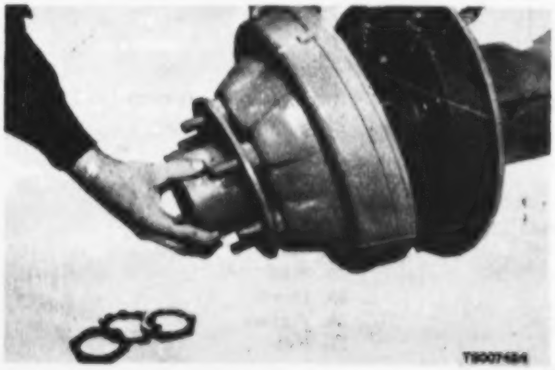


Figure 10-4. Removing Hub and Drum Assembly.

(4) Remove bearing cones, cups, seals and slinger as shown in figure 10-1.

(5) Remove carrier nuts and screws, and lift off the drop gearcase and differential as an assembly.

c. Cleaning and Inspection.

(1) Clean the exterior and interior of the axle housing with solvent, Federal Specification P-D-680.

(2) Clean each bearing in a container filled with (clean) solvent, Federal Specification P-D-680. Wash bearings thoroughly. Remove bearings from solvent and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Repeat above operation until bearings are thoroughly clean. Bearings must be completely free from grease, oil and solidified particles of lubricant.

(3) After washing bearings, blow them dry with compressed air. Be careful to direct air pressure across bearing to avoid spinning. DO NOT SPIN BEARINGS. Bearings may be slowly rotated by hand to facilitate drying procedure.

(4) Inspect bearings carefully to determine if they are in good condition and suitable for further service.

(5) When bearings are clean and dry, lubricate them with new engine oil. Rotate the bearing by hand, and check for wear or rough spots.

(6) Carefully inspect rollers, cages and cups for wear, chipping or nicks.

(7) If any defects are found, the bearings should be scrapped, and replaced with new ones at reassembly.

(8) All parts of the axle, including gears, axle shaft and hub should be washed thoroughly in a Stoddard type cleaning solvent.

(9) Examine the gears for cracked, chipped or scored teeth. If any of these conditions exist, the faulty part should be replaced with a new part.

(10) If magna-flux process is available, use process to check parts. Examine teeth of all gears carefully for wear, pitting, chipping, nicks or scores. If gear teeth show spots where case hardening is worn through, install new gear. Small nicks may be carefully removed with a suitable hone.

(11) Examine axle shafts to make certain that they are not sprung, bent or splines twisted and that shafts are true.

(12) Seals and gaskets should be replaced with new ones at reassembly.

d. Reassembly.

(1) Using a new gasket, install drop gearcase and carrier to axle housing. Tighten mounting screws to 52 - 57 ft/lbs.

(2) Install bowl cover and new gasket. Tighten screws to 25 ft/lbs.

(3) Install bearing cups into wheel hub. Install inner seal and slinger.

(4) Secure hub to drum with studs and nuts. Pack bearings with lubricant (LO 10-3930-633-12 and TM 10-3930-633-12).

(5) Install hub and drum to axle housing. Install bearing nuts and nut lock and adjust bearings as outlined in TM 10-3930-633-12.

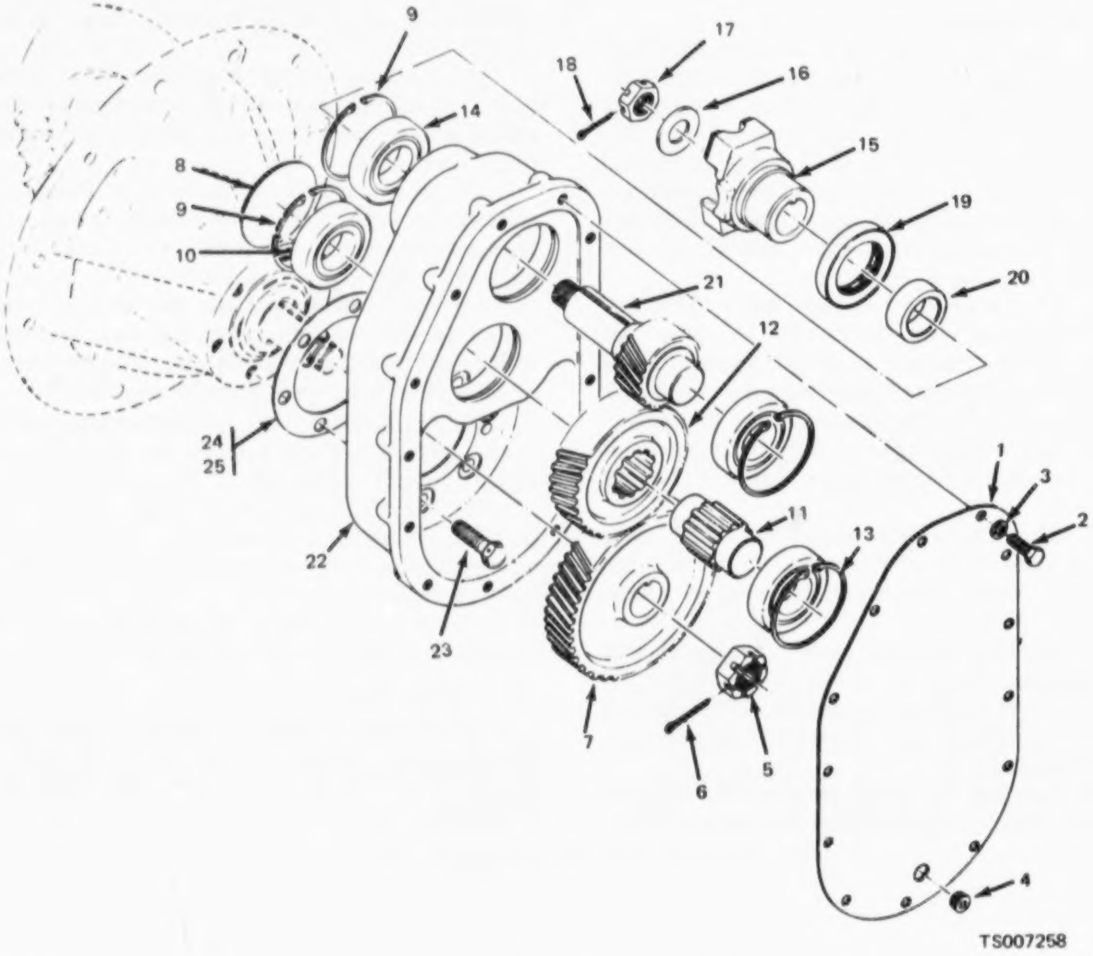
(6) Slide axle shaft into place, and secure with nuts and lockwashers. Tighten axle shaft flange nuts to 52 - 57 ft/lbs.

(7) Install as outlined in Chapter 2, Section IV, and refill differential and drop gearcase with proper oil (LO 10-3930-633-12).

10-3. Differential and Drop Gearcase

a. Removal. Refer to paragraph 10-2 for removal instructions.

b. Disassembly. Refer to figure 10-5 and proceed as follows:



1. Cover
2. Screw
3. Lockwasher
4. Plug
5. Nut
6. Pin
7. Gear
8. Plug
9. Retaining ring
10. Bearing
11. Shaft
12. Gear
13. Ring
14. Bearing
15. Flange
16. Washer
17. Nut
18. Pin
19. Seal
20. Spacer
21. Gear
22. Case
23. Capscrew
24. Gasket
25. Gasket

Figure 10-5. Drop Gear Case.

(1) Remove thirteen cover screws (2) and lockwashers (3) and lift off cover (1).

(2) Remove cotter pin (6) and nut (5). Pull off gear (7).

(3) Cut lockwire and remove screws (23) to separate differential carrier from drop gearcase.

(4) Remove nut (17) and cotter pin (18). Pull off flange (15), washer (16) and seal (19).

(5) Remove expansion plug (8) from case (22). Remove retaining rings (9 and 13), and remove bearings (10 and 14).

(6) Remove pinion gear (21), and idler gear shaft (11) and gear (12).

c. Cleaning and Inspection.

(1) Clean the case and all metal parts in accordance with general cleaning instructions in Chapter 2. Carefully remove all traces of gaskets and gasket cement.

(2) Clean each bearing in a container filled with (clean) solvent, Federal Specification P-D-680. Wash bearings thoroughly. Remove bearings from solvent and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Repeat above operations until bearings are thoroughly clean. Bearings must be completely free from grease, oil and solidified particles of lubricant.

(3) After washing bearings, blow them dry with compressed air. Be careful to direct air pressure across bearing to avoid spinning. DO NOT SPIN BEARINGS. Bearings may be slowly rotated by hand to facilitate drying procedure.

(4) Inspect bearings carefully to determine if they are in good condition and suitable for further service.

(5) When bearings are clean and dry, lubricate them with new engine oil. Rotate the bearing by hand, and check for wear or rough spots.

(6) Carefully inspect races, retainers, and balls for wear, chipping or nicks.

(7) If any defects are found, the bearings should be scrapped, and replaced with new ones at reassembly.

(8) Examine the gears for cracked, chipped or scored teeth. If any of these conditions exist, the faulty part should be replaced with a new part.

(9) If magna-flux process is available, use process to check parts. Examine teeth of all gears carefully for wear, pitting, chipping, nicks or scores. If gear teeth show spots where case hardening is worn through, install new gear. Small nicks may be carefully removed with a suitable hone.

(10) Seals and gaskets should be replaced with new ones at reassembly.

d. Reassembly (see figure 10-5).

(1) Install bearings (10 and 14) into front side of case (22). Install retaining rings (9) and plug (8).

(2) Install gear (12) and shaft (11). Install gear (21). Install bearings (10) on opposite ends of shafts and secure in place by installing retaining rings (9 and 13).

(3) Install spacer (20), seal (19), flange (15) and washer (16). Secure by installing nut (17). Tighten nut to 150 - 175 ft/lbs. and install cotter pin (18).

(4) Install new gaskets (24 and 25), and assemble differential carrier to drop gearcase. Secure by installing screws (23). Tighten screws to 50 - 60 ft/lbs. and lockwire together.

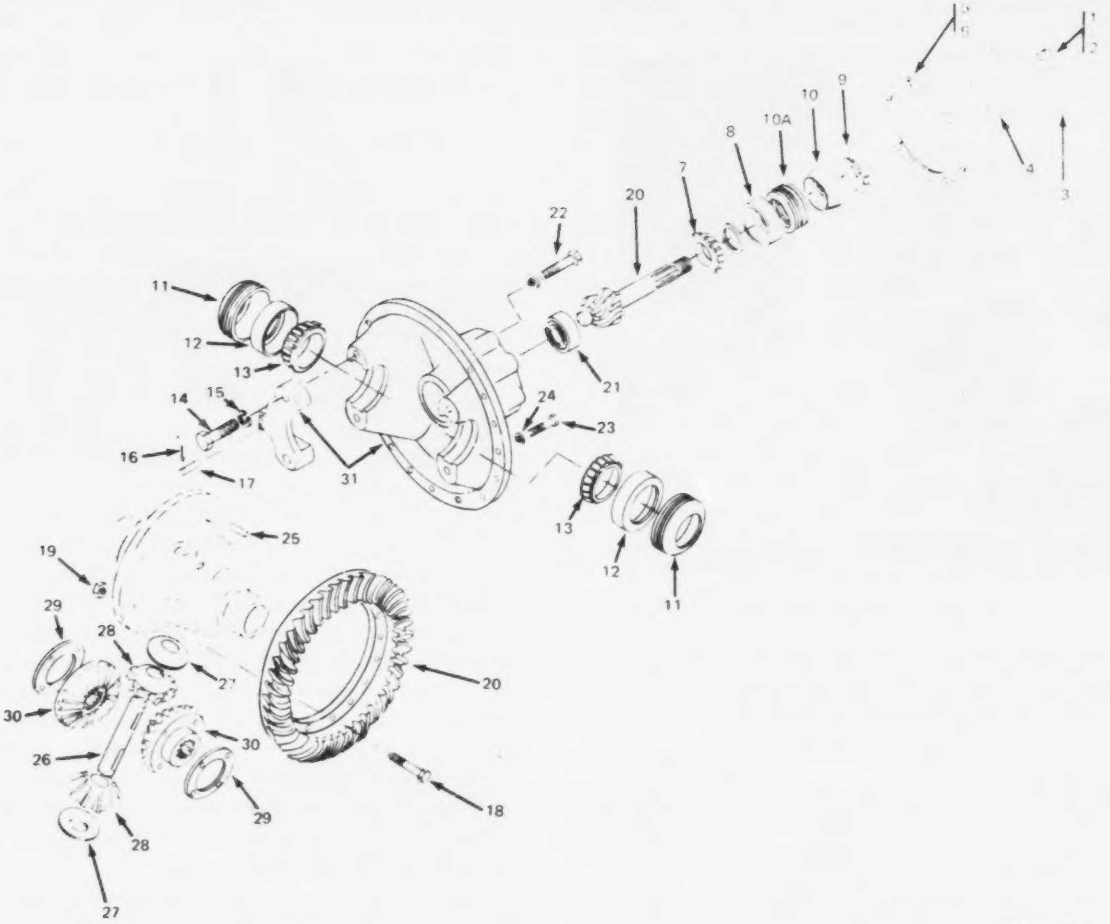
(5) Install gear (7) on differential pinion shaft. Install nut (5) and torque to 150 - 175 ft/lbs. Install cotter pin (6).

(6) Install drain and filler plugs, and position cover (1) on case (22). Install thirteen screws (2) and lockwashers (3). Torque screws to 50 - 57 ft/lbs.

e. Installation. Refer to paragraph 10-2 for installation during axle reassembly.

10-4. Differential Carrier

a. Disassembly. Refer to figure 10-6 for parts identification, noting that parts (1) through (4) are not used with drop gearcase, and proceed as follows: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1. Nut
2. Washer
3. Cotter pin
4. Companion flange
5. Gasket
6. Gasket
7. Cone
8. Cup
9. Cone
10. Cup
11. Adjusting nut
12. Cup
13. Cone
14. Screw
15. Washer
16. Cotter pin
17. Lock pin
18. Capscrew
19. Nut
20. Gear set
21. Pinion
22. Capscrew
23. Capscrew
24. Lockwasher
25. Lock pin
26. Side gear pin
27. Thrust washer
28. Pinion
29. Washer
30. Side gear
31. Housing

Figure 10-6. Differential Carrier Assembly.

(1) Match mark differential bearing caps and housing as shown in figure 10-7 prior to removal.

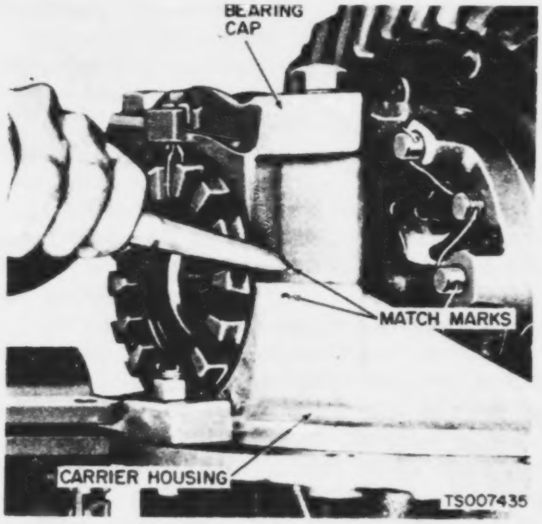


Figure 10-7. Match Marking.

(2) Cut lockwire and remove bearing capscrews, bearing caps, and adjusting nuts.

(3) Lift out differential as shown in figure 10-8.

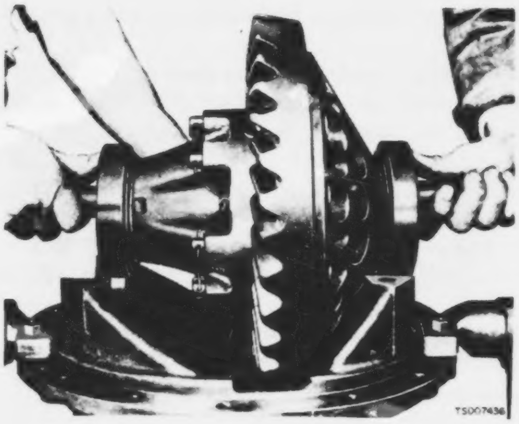


Figure 10-8. Differential Removal.

(4) Remove differential pinion, with bearings assembled, from differential housing. If bearings are to be removed, press the bearings off in an arbor press.

(5) Drive side gear pin out of differential case, and remove differential pinions side gears and thrust washers.

(6) Do not remove ring gear from case unless ring gear is damaged.

(7) Differential bearings may be pressed off the case using an arbor press (fig. 10-9).

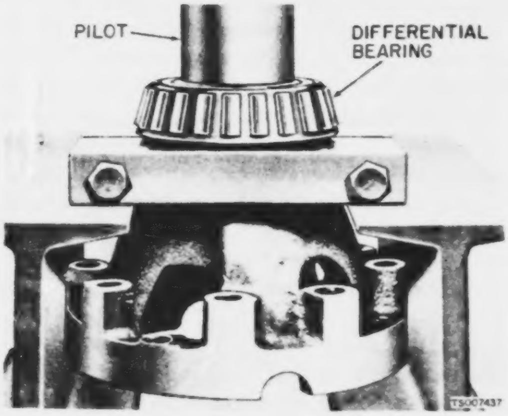


Figure 10-9. Differential Bearing Removal.

b. Cleaning and Inspection.

(1) Clean case and housing parts in solvent, Federal Specification P-D-680.

(2) Clean each bearing in a container filled with (clean) solvent, Federal Specificication P-D-680. Wash bearings thoroughly. Remove bearings from solvent and strike larger side of cone flat against a block of wood to dislodge solidified particles of lubricant. Repeat above operation until bearings are thoroughly clean. Bearings must be completely free from grease, oil and solidified particles of lubricant.

(3) After washing bearings, blow them dry with compressed air. Be careful to direct air pressure across bearing to avoid spinning. DO NOT SPIN BEARINGS. Bearings may be slowly rotated by hand to facilitate drying procedure.

(4) Inspect bearings carefully to determine if they are in good condition and suitable for further service.

(5) When bearings are clean and dry, lubricate them with new engine oil. Rotate the bearing by hand, and check for wear or rough spots.

(6) Carefully inspect rollers, cages and cups for wear, chipping or nicks.

(7) If any defects are found, the bearings should be scrapped and replaced with new ones at reassembly.

(8) Examine the gears for cracked, chipped or scored teeth. If any of these conditions exist, the faulty part should be replaced with a new part.

(9) If magna-flux process is available, use

process to check parts. Examine teeth of all gears carefully for wear, pitting, chipping, nicks or scores. If gear teeth show spots where case hardening is worn through, install new gear. Small nicks may be carefully removed with a suitable hone.

(10) Use new gaskets for reassembly.

c. *Reassembly.*

(1) Press differential pinion bearings on pinion, using an arbor press and tubular pilot which will contact the inner race of the bearing only. Install pinion into differential carrier housing.

(2) Press differential bearings onto case assembly. Bolt ring gear to case and tighten screws around ring gear flange to 82 ft/lbs.

(3) Place thrust washers behind side gears and fit side gears into differential case. Position pinion gears in mesh with side gears, and with thrust washers in place, press side gear pin through pinions and case.

(4) Install differential assembly into housing, with bearing cups in place on differential case bearings. Position threaded adjuster nuts as shown in figure 10-10 and install bearing caps.

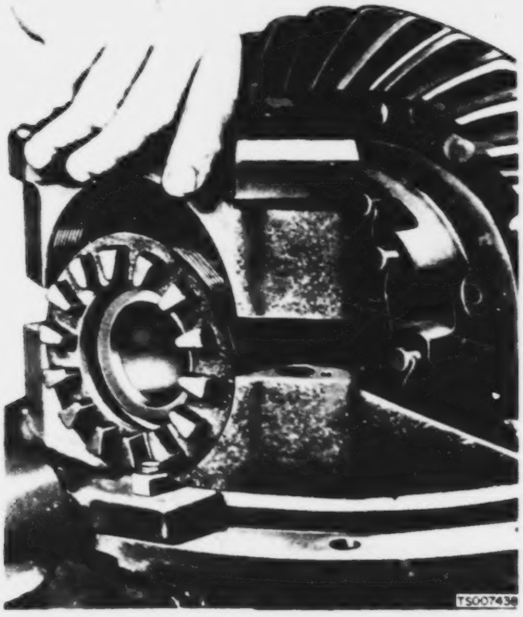


Figure 10-10. Installing Differential Bearing Caps.

(5) Check ring gear and pinion contact by applying oiled red lead to the ring gear teeth. Rotate the pinion through one full turn of the ring gear. The red lead will be squeezed away from the areas of tooth contact, leaving bare spots on the ring gear teeth which are the exact size and shape of the tooth contact.

(6) The proper pattern (on drive side of teeth) will be centered between root and top of the ring gear teeth and will be slightly toward the toe of the tooth; that is, closer to the inside diameter. Adjust pinion in or out, and ring gear side-to-side, to obtain this pattern. Adjustment will be made by means of shims, installed under the differential and pinion bearing cups.

(7) Adjust nuts over differential bearings so that 5 - 15 in./lbs. of torque (on spring scale) is required to start ring gear turning. When this preload is obtained, install the nut lock and cotter pin to secure the adjustment.

(8) Differential is ready for assembly to drop gearcase. Refer to paragraph 10-3, under "Reassembly."

10-5. Rear Springs

a. *Removal.* Refer to Chapter 2, Section IV, for procedures covering removal of the rear axle and springs.

b. *Cleaning and Inspection.*

(1) Clean the spring assemly using solvent, Federal Specification P-D-680, and a stiff wire brush.

(2) Inspect bushings in the spring eyes for wear or deterioration. Replace as required.

(3) Check for loose center bolt or rebound clips and tighten as necessary.

(4) Check for broken or distorted leaves, and replace spring assembly if any leaf is bent or broken.

c. *Installation.* Refer to Chapter 2, Section IV, for procedures covering installation of springs and axle.

CHAPTER 11

REPAIR OF STEERING SYSTEM

11-1. General

a. Steering System. The steering system consists of the steering wheel and column, the steering gear and pitman arm, the drag link, steering knuckles, and the tie rod. Refer to figure 11-1 for the layout of the steering system. Action of the steering gear (in response to the turning of the steering wheel) is transmitted to the front axle steering knuckles through the pitman arm and drag link. The tie rod transmits the steering action from one steering knuckle to the other.

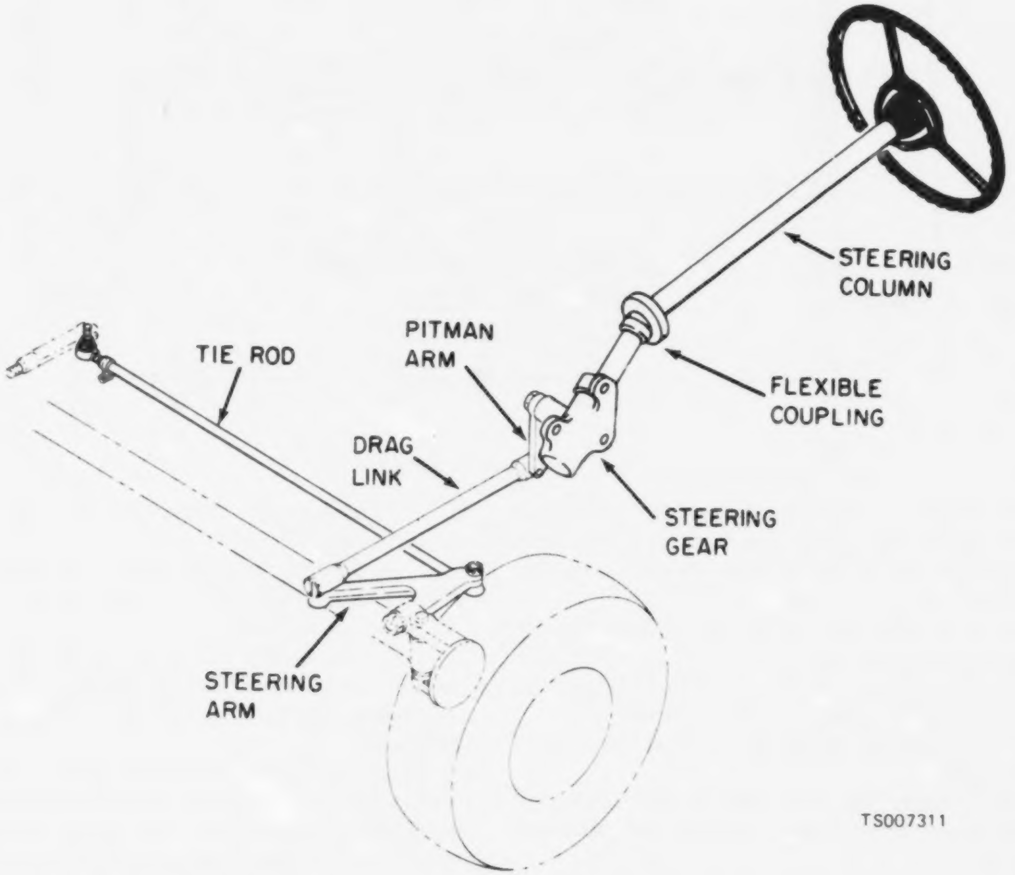


Figure 11-1. Steering System.

b. Steering Gear. The recirculating ball type gear consists of a "ball nut" connected to the steering worm and in mesh with the sector gear. Precision finished helical grooves within the ball nut match helical grooves in the worm. The ball bearings roll within these grooves when the steering wheel is turned. There are two complete circuits using tubular ball guides to deflect the balls away from their helical path at one end of the grooves and guide them back to the other end.

11-2. Tie Rod

a. Adjustment (Front Wheel Toe-in). Front wheel toe-in should be set at zero. This is achieved by lengthening or shortening the tie rod as required to set the leading edges of the front tires at exactly the same width as the trailing edge. Proceed as follows to check and adjust.

(1) Turn the front wheels to the exact straight-ahead position.

(2) Check the toe-in of front wheels after rolling the truck ahead one full revolution of the wheels (with only the weight of the truck on the tires).

(3) Actual toe-in measurements should be taken at hub-height, between the two points on the center of the tread at the rear of the tires. See figure 11-2.

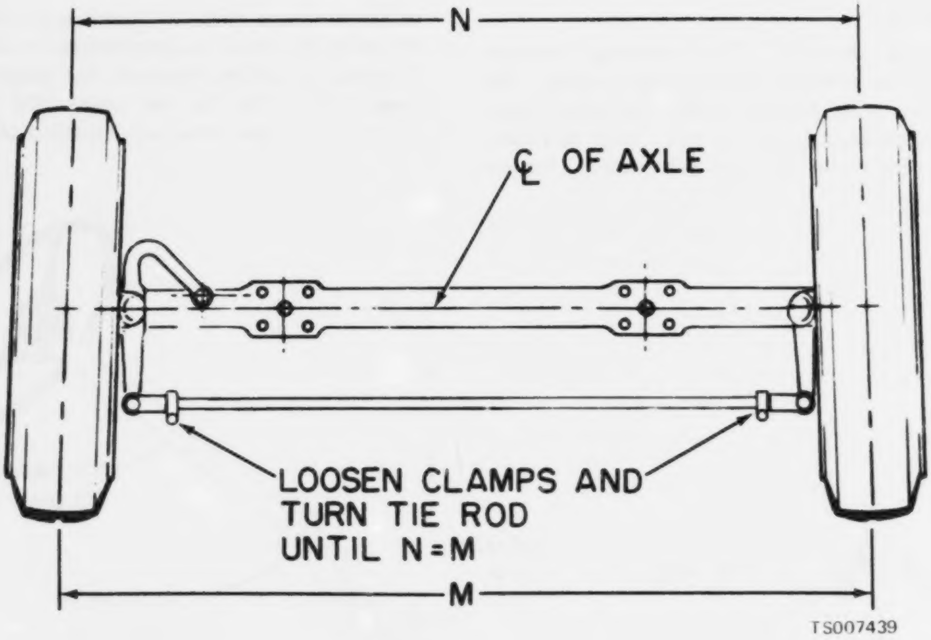


Figure 11-2. Tie Rod Adjustment.

(4) Mark the point and roll the truck ahead so that the points are in the front at hub-height and measure the distance between the same two points on the tire treads.

(5) The difference in the two measurements is the actual toe-in or toe-out.

(6) To adjust the toe-in, turn the steering wheel so that the gear is in the mid-position.

(7) Loosen the clamping bolts on the ends of the tie rod.

(8) Rotate the tie rod in the direction necessary to bring toe-in within the specified range (zero).

(9) Tighten the clamp bolts on the tie rod ends.

b. Removal. The tie rod is secured to the axle at each end by a nut and cotter pin on the end of each ball stud. To remove the tie rod, remove cotter pins and nuts and tap the ball stud ends free of the steering arms.

c. Disassembly, Repair and Reassembly.

(1) Loosen clamps on each tie rod end, and unscrew and remove the tie rod ends from the tube.

(2) Remove clamp and clamp bolts.

(3) Clean all parts in solvent, Federal Specification P-D-680.

(4) Check for cracks, dents, corrosion, and in particular, wear and damaged threads. Replace all worn or defective parts.

(5) Reassemble clamps on tie rod tube and install tie rod ends. Do not tighten clamps, as tie rod ends will have to be adjusted at assembly with axle.

d. Installation. Install tie rod to front axle, and secure ball studs in steering arms by installing castellated nut and cotter pins. Adjust toe-in as outlined in subparagraph *a*. Lubricate in accordance with LO 10-3930-633-12.

11-3. Steering Gear

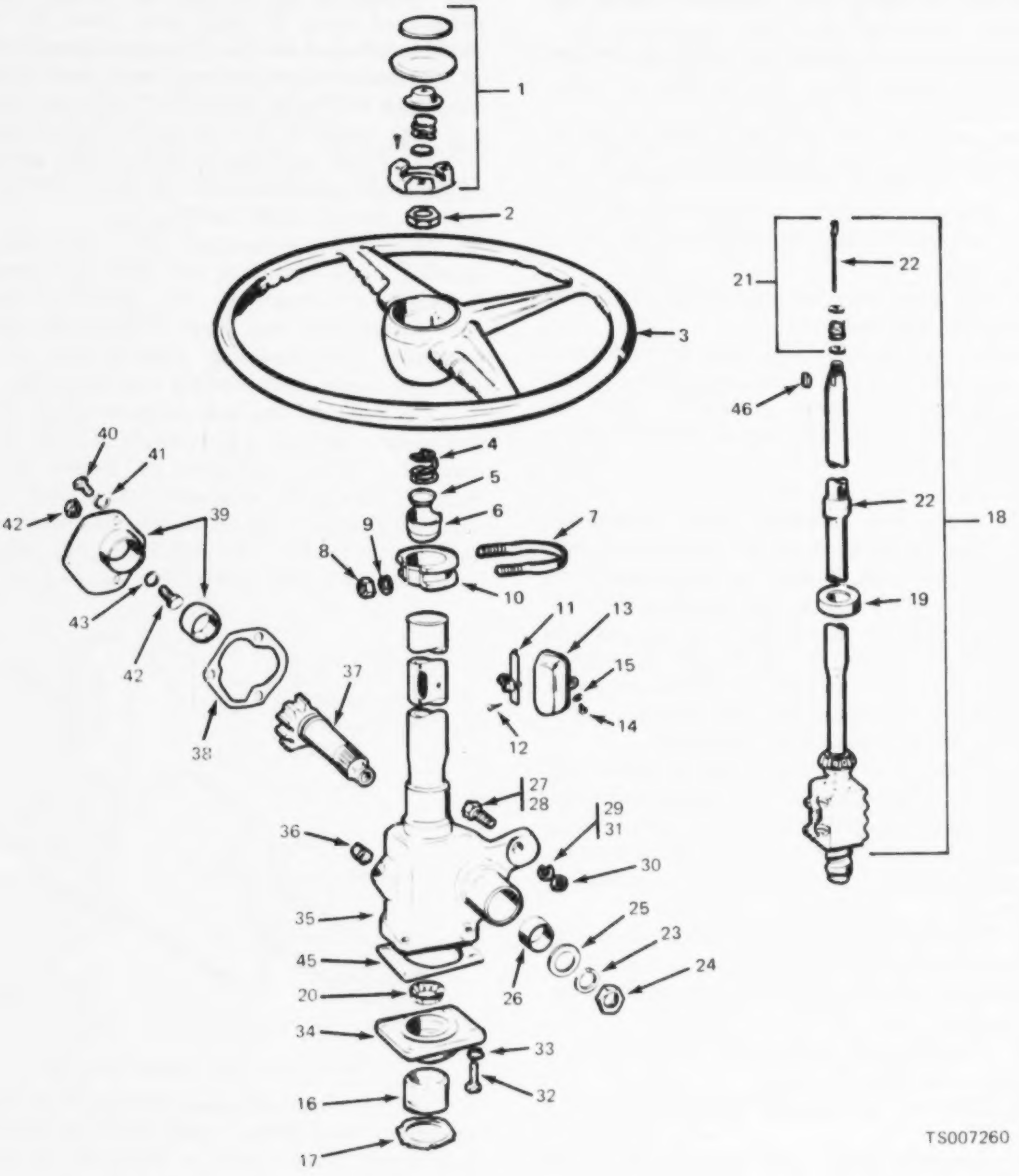
a. Removal. Refer to Chapter 2, Section IV, for complete removal procedures.

b. Disassembly.

NOTE

As with any ball bearing unit, the steering gear parts must be kept free of dirt. Clean paper or rags should be spread on the bench before starting disassembly of the steering gear.

Refer to figure 11-3 for parts identification and proceed as follows: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TS007260

1. Horn button kit
2. Nut
3. Steering wheel
4. Upper bearing spring
5. Seat
6. Upper bearing
7. Clamp
8. Nut
9. Lockwasher
10. Cushion
11. Connector
12. Screw
13. Cover
14. Screw
15. Lockwasher
16. Adjuster, thrust
17. Locknut
18. Shaft and ball nut assembly
19. Cup
20. Cone
21. Terminal assembly
22. Cable and contact
23. Lockwasher
24. Nut
25. Seal
26. Bushing
27. Screw
28. Screw
29. Lockwasher
30. Nut
31. Washer
32. Screw
33. Lockwasher
34. End cover
35. Housing
36. Plug
37. Sector shaft
38. Gasket
39. Cover and bushing
40. Screw
41. Lockwasher
42. Adjusting screw
43. Shim
44. Nut
45. Gasket

Figure 11-3. Steering Gear and Column.

(2) Loosen the locknut (17) on the worm bearing adjuster, and turn the adjuster counterclockwise a few turns. Place a pan under the assembly to catch the lubricant and remove the

three bolts (40) and washers (41) attaching side cover (39) to housing (35). Remove pitman arm nut (24).

(3) Pull the side cover (39) with the output shaft (37) attached from the housing.

NOTE

If the sector does not clear the opening in the housing easily, turn the wormshaft by hand until the sector will pass through the opening in the housing.

(4) Remove the worm bearing adjuster (16), adjuster locknut (17) and lower bearing (20) from housing (35).

(5) Pull shaft and nut assembly (18) out of housing from the bottom.

(6) Remove locknut (44) from lash adjuster screw (45). Remove side cover from output shaft by turning adjuster screw clockwise. Slide adjuster (42) and shim (43) out of slot in end of output shaft (37).

c. Cleaning and Inspection.

(1) With the steering gear completely disassembled, wash all parts in cleaning solvent. Dry them thoroughly with air. With a magnifying glass, inspect the bearings and bearing cups for signs of indentation. Also check for any signs of chipping or breakdown of the surface. Any parts that show signs of damage should be replaced.

(2) Inspect all seals. Any seal that is worn or has been removed should be replaced.

(3) Inspect the output shaft for wear and check the fit of the shaft in the housing bushings.

(4) Inspect the fit of the output shaft in its bushing in the side cover. If this bushing is worn, a new side cover and bushing assembly should be installed.

(5) Check steering gear wormshaft assembly for bent or damaged shaft. Never attempt to salvage steering parts by welding or straightening.

d. Repair.

(1) Replace side cover and bushing as an assembly if bushing is worn.

(2) Press in new output shaft bushings, if worn.

(3) Replace seals, and gaskets prior to reassembly.

(4) Replace entire ball nut and shaft if there is evidence of sticking or binding.

e. Reassembly. After a major service overhaul where all of the lubricant has been washed out of the steering gear assembly, the threads of the adjuster, side cover bolts and lash adjuster should be coated with a suitable nondrying, oil-resistant sealing compound such as Permatex No. 2 or equivalent. This is to prevent leakage of gear lubricant from the steering gear assembly. The compound should not be applied to female threads and extreme care should be exercised in applying this compound to the bearing adjuster, as the compound must be kept away from the wormshaft bearing. Also apply steering gear lubricant to wormshaft bearings and seal, output shaft, bushings and seal, wormshaft grooves and ball nut rack teeth to provide initial lubrication.

(1) Wrap wormshaft (stub shaft) serrations with plastic (electrician's) tape to prevent cutting seal lip during shaft installation.

(2) With wormshaft seal, bearings and bearing cups installed and ball nut assembly installed on wormshaft, slip upper ball bearing over wormshaft and insert wormshaft and nut assembly into housing, feeding end of shaft through upper ball bearing cup and seal.

(3) Position the lash adjuster with shim in the slotted end of output shaft. Check the end clearance, which should not be greater than .002 inch. If clearance is greater than .002 inch, a steering gear lash adjuster shim unit is available. It contains four shims: .063 inch, .065 inch, .067 inch and .069 inch thick. See figure 11-4.

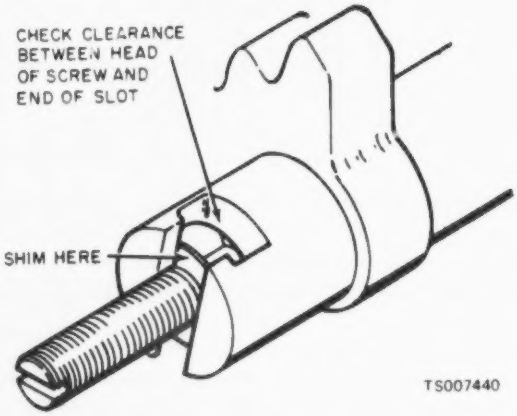


Figure 11-4. Lash Adjuster Clearance.

(4) After lash adjuster end clearance has been adjusted, start output shaft pilot into bushing in side cover. Then, using a screwdriver, through the hole in cover, turn lash adjuster in a counterclockwise direction to pull output shaft pilot into its bushing as far as it will go.

(5) Rotate wormshaft by hand until ball nut is about in the center of travel. This is to make sure that the rack and sector will engage properly with center tooth of the sector entering center tooth space of the nut.

(6) Place a new gasket on side cover, then push side cover assembly, including output shaft, into place. After making sure there is some lash

between rack and sector teeth, assemble and tighten side cover bolts to 25—35 ft/lbs.

NOTE

Be careful not to damage seal when installing output shaft. Good practice would be to wrap output shaft serrations with plastic (electrician's) tape to prevent cutting seal lip during shaft installation.

(7) Install output shaft adjuster screw locknut on screw. Do not tighten at this time.

(8) Fill steering gear with recommended lubricant in accordance with LO 10-3930-633-12.

f. *Installation.* Refer to Chapter 2, Section IV, for details on installation of steering gear assembly.

g. *Adjustment.* Refer to TM 10-3930-633-12 for procedures covering thrust and lash adjustment of the steering gear installed in the vehicle.

CHAPTER 12

REPAIR OF FRONT AXLE AND SPRINGS

12-1. General

The front axle assembly is a light truck, I-beam type axle. The axle is suspended on semi-elliptical leaf springs. King pins are a straight design, and are held in place by tapered draw keys. The steering knuckles pivot on delrin bushings about the king pins, and a ball thrust bearing is used between the lower thrust faces of the steering knuckle and axle center. See figure 12-1 for details of the installation.

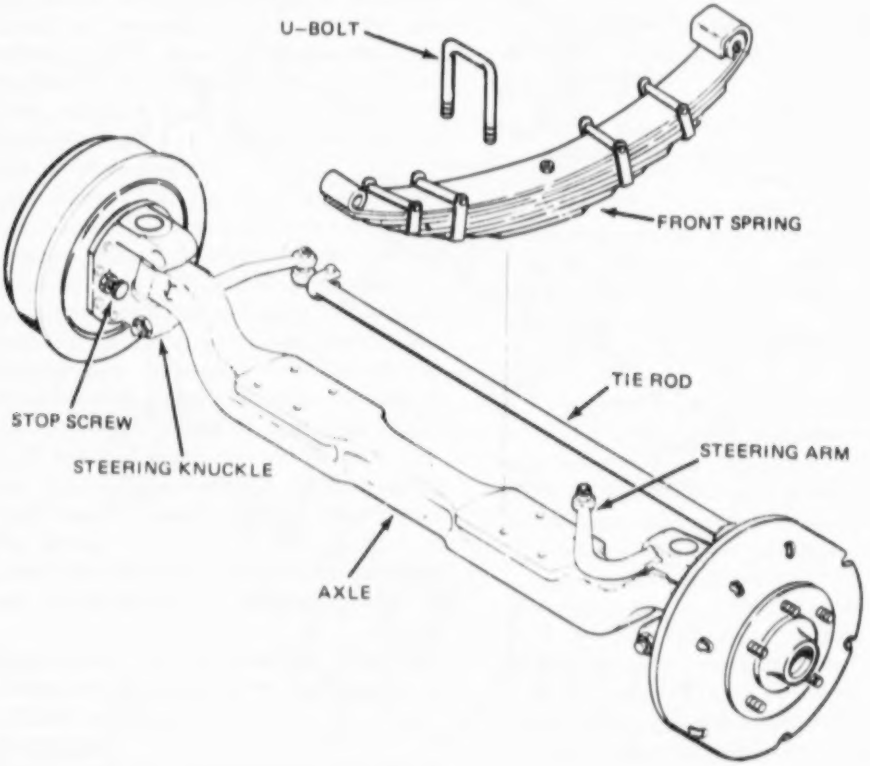

U–BOLT
FRONT SPRING
TIE ROD
STEERING ARM
STOP SCREW
STEERING KNUCKLE
AXLE
TS007314

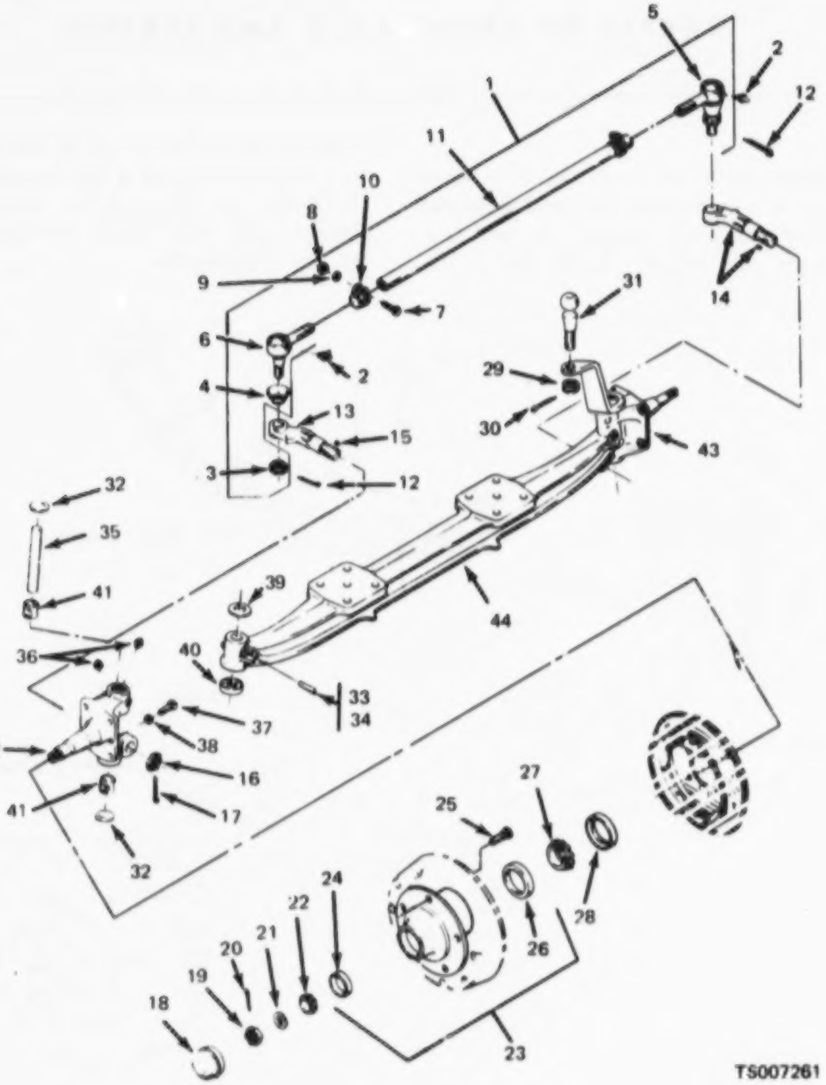
Figure 12-1. Front Axle Installation.

12-2. Front Axle Repair

a. Removal. Refer to Chapter 2, Section IV, for procedures covering removal of the front axle assembly.

b. Disassembly.

(1) Refer to figure 12-2 for parts identification and proceed as follows: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1. Axle assembly
2. Lube fitting
3. Hex nut
4. Dust cover
5. Tie rod end, R.H.
6. Tie rod end, L.H.
7. Capscrew
8. Hex nut
9. Lockwasher
10. Clamp
11. Rod
12. Cotter pin
13. Steering arm, R.H.
14. Steering arm, L.H.
15. Woodruff key
16. Hex nut
17. Cotter pin
18. Hub cap
19. Hex nut
20. Cotter pin
21. Washer
22. Bearing cone
23. Hub and cups
24. Cup, outer
25. Stud, wheel
26. Cup, inner
27. Cone
28. Seal
29. Nut
30. Cotter pin
31. Ball stud
32. Plug
33. Key
34. Key
35. Knuckle pin
36. Lube fitting
37. Capscrew
38. Hex nut
39. Shim
40. Bearing
41. Bushing
42. Steering knuckle, R.H.
43. Steering knuckle, L.H.
44. Axle beam

Figure 12-2. Front Axle Assembly.

(2) Remove tie rod and parts as outlined in Chapter 11.

(3) Remove castellated nut, cotter pin and ball stud from L. H. steering knuckle (43).

(4) Remove hub caps (18). Remove castellated nut (19), cotter pin (20) and bearing cones (22) from each end of axle.

(5) Pull off brake drum with bearing cups (24 and 26), cone (27) and seal (28).

(6) Remove brake assemblies from steering knuckles.

(7) Remove nuts (16), cotter pins (17) and steering arms (14 and 13).

(8) Drive out draw keys (33 and 34) from the small end. Remove expansion plugs (32) and drive out knuckles pins (35), to free knuckles (42 and 43), shims (39) and bearings (40) from axle beam (44).

c. Cleaning and Inspection.

(1) Clean parts having ground and polished surfaces, such as knuckle pins, knuckle pin sleeves, bearings and spindles, with solvent, Federal Specification P-D-680. Do not clean these parts in a hot solution tank or with water and alkaline solutions such as sodium hydroxide, orthosilicates or phosphates.

(2) Parts should be thoroughly dried immediately after cleaning. Use soft, clean, lintless, absorbent paper towels or wiping rags free of abrasive material, such as lapping compound, metal filings or contaminated oil. Bearings should never be dried by spinning with compressed air.

(3) Inspect the steering knuckle thrust bearing, wheel bearing cones and cups. Replace if rollers or cups are worn, pitted or damaged in any way. If wheel bearing cups are to be replaced, remove from hubs with a suitable puller. Avoid the use of drift and hammers as they may easily mutilate cup bores.

(4) Inspect the steering knuckles and replace if indications of weakness or excessive wear is found.

(5) Check wear of the knuckle pins and bushings. Compare with new part dimensions to determine extent of wear.

d. Repair.

(1) Repair generally consists of replacement of defective parts.

(2) Straightening of bent parts should be done cold. Various components are heat-treated and hot straightening would destroy some of the heat treatment.

(3) Axle centers (that are bent no more than ½ inch) may be straightened cold; if bent more than ½ inch, they should be replaced.

(4) Bent steering arms or knuckles should be replaced rather than straightened.

e. Replacement of Knuckle Bushings. Nylon bushings are used on production axles and are also used as a replacement for axles having the bronze type bushing. For installing nylon replacement, proceed as follows:

(1) Split metal bushings with hacksaw and drive bushings from knuckle.

(2) Remove nicks and burrs from knuckle bushing bore and polish with medium grit abrasive.

(3) Apply chassis lube to bushings and knuckle bore and install bushings.

f. Reassembly.

(1) Make certain that the knuckle pin hole in the axle center is clean and dry.

(2) Position and support the steering knuckle assembly (41 or 42, fig. 12-2) on the axle center (43).

(3) Slide the thrust bearing (40) between the lower face of the axle center and the lower steering knuckle yoke.

NOTE

Thrust bearings that are not marked "TOP" to indicate proper installation orientation must be positioned with retainer lip down.

(4) Align the steering knuckle yoke holes with axle center and thrust bearing bores.

(5) Place a jack under the lower side of steering knuckle yoke and raise knuckle so that all clearance is taken up between lower yoke, thrust bearing (40) and lower face of axle center end.

(6) Check the clearance between the top face of upper axle center end and lower face of upper knuckle pin boss. The clearance must not exceed .005 inches. Washers and shims (39) are available in various thicknesses to take up this clearance and hold it within the desired .005 inch tolerance.

(7) Align flats on knuckle pin (35) with the centerline of the draw key holes. Drive knuckle pin (35) through knuckle yoke, axle center and thrust bearing, working from top of axle.

(8) Install the draw keys (33) into the axle center. Drive the draw key in so that the flat on the key will mate with the corresponding flats on the knuckle pin. Seat pin firmly in place.

(9) Install expansion plugs (32) in knuckle bores, top and bottom.

(10) Reinstall backing plates and brake assemblies, if previously removed. Also, if axle assembly was removed from truck chassis, reinstall at this time.

(11) Install tie rod as outlined in Chapter 11.

(12) Install brake drum and hubs with bearings in place and properly lubricated according to instructions in TM 10-3930-633-12.

(13) Axle is ready for installation.

g. Installation.

(1) Refer to Chapter 2, Section IV, for in-

stallation procedures on the front axle and springs.

(2) Adjust front wheel bearings in accordance with procedures outlined in TM 10-3930-633-12.

(3) Lubricate axle assembly as indicated in LO 10-3930-633-12.

(4) Adjust steering stop screws as outlined in TM 10-3930-633-12.

12-3. Front Springs

a. Removal. Refer to Chapter 2, Section IV, for procedures covering removal of front axle and springs.

b. Cleaning and Inspection.

(1) Clean the spring assembly using solvent, Federal Specification P-D-680 and a stiff wire brush.

(2) Inspect bushings in the spring eyes for wear or deterioration. Replace as required.

(3) Check for loose center bolt or rebound clips and tighten as necessary.

(4) Check for broken or distorted leaves, and replace spring assembly if any leaf is bent or broken.

c. Installation. Refer to Chapter 2, Section IV, for procedures covering installation of springs and axle.

APPENDIX A

REFERENCES

A-1. FIRE PROTECTION

TB 5-4200-200-10	Hand Portable Fire Extinguishers Approved for Army Users

A-2. LUBRICATION

C91001L	Fuels, Lubricants, Oils and Waxes
LO 10-3930-633-12	Lubrication Order for Tractor, Wheeled, Warehouse, Army Model MHE-228, Clark Model CTE-40-2330237

A-3. PAINTING

TM 9-213	Painting Instructions for Field Use

A-4. RADIO SUPPRESSION

TM 11-483	Radio Interference Suppression

A-5. MAINTENANCE

TB ORD 651	Use of Antifreeze Solutions and Cleaning Compounds in Engine Cooling Systems
TM 38-750	Army Equipment Procedures
TM 10-3930-633-12	Operator and Organizational Maintenance Manual for Tractor, Wheeled, Warehouse, Army Model MHE-228, Clark Model CTE-40-2330237
DMWR 10-3930-633	Depot Maintenance Work Requirement for Tractor, Wheeled, Warehouse, Army Model MHE-228, Clark Model CTE-40-2330237
TM 10-3930-633-20P	Organizational Maintenance Repair Parts and Special Tools List for Tractor, Wheeled, Warehouse, Army Model MHE-228, Clark Model CTE-40-2330237
TM 10-3930-633-34P	DS, GS, and Depot Maintenance Repair Parts and Special Tools List for Tractor, Wheeled, Warehouse, Army Model MHE-228, Clark Model CTE-40-2330237
TM 9-6140-200-15	Operation and Organizational Field and Depot Maintenance Storage Batteries, Lead Acid Type
TM 5-764	Electric Motor and Generator Repair
TB 385-101	Safety Use of Cranes, Crane-Shovel Dragline, and Similar Equipment Near Electric Power Lines

A-6. SHIPMENT AND STORAGE

TB 740-93-2	Preservation of USAMEC Mechanical Equipment for Shipment and Storage
TM 740-90-1	Administrative Storage of Equipment

A-7. DESTRUCTION OF ARMY MATERIEL TO PREVENT ENEMY USE

TM 750-244-3	Procedures for Destruction of Equipment to Prevent Enemy Use (Mobility Equipment Command)

A-8. SAFETY

TB MED 251	Noise, etc.

INDEX

Paragraph Page

A

- Adjustments:
  - Ring gear and pinion 10-4 10-4
  - Tie rod 11-2 11-1
  - Vacuum booster pushrod 9-9 9-8
- Administrative storage 1-6 1-1
- Alternator:
  - Cleaning 3-4 3-1
  - General 3-1 3-1
  - Inspection 3-4 3-1
  - Maintenance 3-3 3-1
  - Repair 3-4 3-1
- Axle, front:
  - Installation 2-27 2-18
  - Removal 2-27 2-18
  - Repair 12-2 12-1
- Axle, rear:
  - Adjustment 10-4 10-4
  - Installation 2-26 2-16
  - Removal 2-27 2-18
  - Repair 10-2 10-1

B

- Bearings, main:
  - Cleaning 6-32 6-33
  - Disassembly 6-29 6-28
  - Inspection 6-32 6-33
  - Installation 6-33 6-33
  - Reassembly 6-29 6-28
  - Removal 6-29 6-28
- Block, cylinder:
  - Cleaning 6-28 6-25
  - Disassembly 6-10 6-4
  - Inspection 6-23 6-23
  - Installation 6-12 6-11
  - Reassembly 6-25 6-22
  - Reboring 6-24 6-22
- Brake system 9-6 9-2
- Brakes, wheel 9-6 9-2

C

- Camshaft:
  - Cleaning 6-40 6-39
  - Inspection 6-40 6-39
  - Installation 6-39 6-38
  - Removal 6-39 6-38
- Carburetor:
  - Cleaning 4-4 4-3
  - Disassembly 4-4 4-3
  - Inspection 4-4 4-3
  - Reassembly 4-4 4-3
- Cleaning:
  - Axle, front 12-2 12-1
  - Axle, rear 10-2 10-1
  - Bearing, main 6-32 6-33
  - Block, cylinder 6-22 6-21
  - Brake vacuum power unit 9-9 9-8
  - Camshaft 6-40 6-39
  - Carburetor 4-4 4-3
  - Connecting rods 6-31 6-32
  - Cover, gear 6-36 6-35
  - Crankshaft 6-30 6-32

Paragraph Page

- Cleaning - continued:
  - Cylinder, wheel 9-6 9-2
  - Cylinder block 6-22 6-21
  - Differential 10-4 10-4
  - Engine alternator 3-4 3-1
  - Engine starter 3-6 3-6
  - Exhaust valves, intake and 6-17 6-17
  - Gear, steering 11-3 11-2
  - Gear cover 6-36 6-35
  - Intake and exhaust valves 6-17 6-17
  - Main bearings 6-32 6-33
  - Oil pan 6-46 6-43
  - Oil pump 6-45 6-41
  - Pan, oil 6-46 6-43
  - Pistons 6-26 6-23
  - Pump, oil 6-45 6-41
  - Rods, connecting 6-31 6-32
  - Starter, engine 3-6 3-6
  - Steering gear 11-3 11-2
  - Transmission torque converter 7-11 7-11
  - Valve, transmission control 7-13 7-17
  - Valves, intake and exhaust 6-17 6-17
  - Wheel cylinder 9-6 9-2
  - Wheels 9-4 9-2
- Connecting rods:
  - Cleaning 6-31 6-32
  - Disassembly 6-28 6-25
  - Inspection 6-31 6-32
- Crankshaft:
  - Cleaning 6-30 6-32
  - Disassembly 6-29 6-28
  - Inspection 6-30 6-32
  - Installation 6-29 6-28
  - Reassembly 6-29 6-28
  - Removal 6-29 6-28
- Cylinder, wheel:
  - Cleaning 9-6 9-2
  - Disassembly 9-6 9-2
  - Inspection 9-6 9-2
  - Installation 9-6 9-2
  - Reassembly 9-6 9-2
  - Removal 9-6 9-2
- Cylinder block:
  - Cleaning 6-22 6-21
  - Inspection 6-22 6-21
  - Reboring 6-24 6-22

D

- Data, tabulated:
  - Alternator 1-8 1-3
  - Brakes, wheel 1-8 1-3
  - Carburetor 1-8 1-3
  - Engine 1-8 1-3
  - Transmission 1-8 1-3
- Description 1-7 1-1
  - Alternator 3-1 3-1
  - Axle, front 12-1 12-1
  - Axle, rear 10-1 10-1
  - Brake system 9-5 9-2
  - Carburetor 4-4 4-3
  - Cooling system 5-1 5-1
  - Distributor 3-7 3-9

	Paragraph	Page
Description - continued:		
Engine	6-1	6-1
Fuel system	4-1	4-1
Propeller shaft	8-1	8-1
Starter	3-5	3-6
Torque-converter	7-11	7-11
Transmission	7-1	7-1
Differences in models	1-9	1-4
Differential:		
Cleaning	10-4	10-4
Disassembly	10-4	10-4
Inspection	10-4	10-4
Reassembly	10-4	10-4
Direct support, general support and depot maintenance repair parts	2-2	2-1
Disassembly:		
Alternator	3-4	3-1
Axle, front	12-2	12-1
Axle, rear	10-2	10-1
Bearings, main	6-29	6-28
Brakes	9-6	9-2
Carburetor	4-4	4-3
Cylinder head	6-14	6-13
Distributor	3-8	3-10
Engine	6-10	6-4
Oil pump	6-45	6-41
Propeller shaft	8-3	8-1
Starter	3-6	3-6
Steering gear	11-3	11-2
Transmission:	7-12	7-11
Control valve body	7-13	7-17
Extension housing	7-16	7-22
Front clutch	7-23	7-28
Front pump	7-20	7-26
Front servo	7-14	7-20
Governor	7-17	7-23
Pressure regulator	7-18	7-24
Rear clutch	7-22	7-27
Rear pump	7-21	7-27
Rear servo	7-15	7-21
Vacuum booster	9-9	9-8
Distributor:		
Cleaning	3-8	3-10
Disassembly	3-8	3-10
Inspection	3-8	3-10
Reassembly	3-8	3-10
Repair	3-8	3-10

E

	Paragraph	Page
Engine:		
Assembly	6-12	6-11
Bearings, main	6-32	6-33
Block, cylinder	6-22	6-21
Camshaft	6-37	6-36
Connecting rods	6-31	6-32
Cover, front	6-36	6-35
Crankshaft	6-29	6-28
Cylinder block	6-22	6-21
Cylinder head	6-13	6-13
Exhaust valves	6-17	6-17
Gears, timing	6-37	6-36
Installation	2-24	2-13
Intake valves	6-17	6-17
Main bearings	6-32	6-33
Oil pan	6-43	6-41
Oil pump	6-45	6-41
Engine - continued:		
Pan, oil	6-43	6-41
Pistons	6-26	6-23
Pump, oil	6-45	6-41
Removal	2-24	2-13
Rods, connecting	6-31	6-32
Tabulated data	1-8	1-3
Valves, exhaust	6-17	6-17
Valves, intake	6-17	6-17

F

	Paragraph	Page
Forms and records	1-2	1-1
Front axle	12-2	12-1
Fuel tank	4-2	4-3

G

	Paragraph	Page
Gear, steering:	11-3	11-2
Installation	2-29	2-19
Removal	2-29	2-19
Repair	11-3	11-2
General cleaning	2-7	2-7
General disassembly	2-6	2-7
General inspection	2-8	2-8
General reassembly	2-10	2-10
General removal	2-5	2-7
General repair	2-9	2-9
Governor	7-17	7-23

I

	Paragraph	Page
Inspection:		
Alternator	3-4	3-1
Axle, front	12-2	12-1
Axle, rear	10-2	10-1
Bearings, main	6-32	6-33
Block, cylinder	6-23	6-21
Brakes	9-6	9-2
Camshaft	6-40	6-39
Carburetor	4-4	4-3
Crankshaft	6-30	6-32
Connecting rods	6-31	6-32
Cylinder head	6-15	6-14
Cylinder, wheel	9-6	9-2
Differential	10-4	10-4
Engine	6-11	6-10
Fuel tank	4-2	4-3
Gear, steering	11-3	11-2
Governor	7-17	7-23
Main bearings	6-32	6-33
Oil pan	6-46	6-43
Oil pump	6-45	6-41
Pistons	6-26	6-23
Pump, oil	6-45	6-41
Radiator	5-3	5-1
Rod, connecting	6-31	6-32
Spring, front	12-3	12-4
Spring, rear	10-5	10-7
Starter	3-6	3-6
Steering gear	11-3	11-2
Tie rod	11-2	11-1
Torque converter	7-11	7-11
Transmission	7-24	7-31
Installation:		
Axle, front	2-27	2-18
Axle, rear	2-26	2-16
Bearings, main	6-33	6-33
Camshaft	6-39	6-38
Carburetor	4-4	4-3

Paragraph Page

Installation - continued:
- **Crankshaft** 6-29 6-38
- **Cylinder head** 6-21 6-20
- **Differential** 10-4 10-4
- **Engine** 2-24 2-13
- **Fuel tank** 4-2 4-1
- **Governor** 7-17 7-23
- **Gears, timing** 6-39 6-38
- **Intake and exhaust valves** 6-21 6-20
- **Main bearings** 6-32 6-33
- **Oil pan** 6-43 6-41
- **Oil pump** 6-44 6-41
- **Pistons** 6-28 6-25
- **Pump, oil** 6-44 6-41
- **Rear axle** 2-26 2-16
- **Rods, connecting** 6-28 6-25
- **Steering gear** 2-29 2-19
- **Tires** 9-2 9-1
- **Torque converter** 7-11 7-11
- **Transmission** 2-25 2-14
- **Valves** 6-21 6-20

M

Main bearings:
- Cleaning 6-31 6-32
- Inspection 6-32 6-33
- Installation 6-33 6-33

Manifold vacuum test 6-7 6-2

Main seals 6-36 6-35

O

Oil pan 6-43 6-41
- Cleaning 6-46 6-43
- Inspection 6-46 6-43
- Installation 6-43 6-41
- Removal 6-43 6-41

Oil pump:
- Cleaning 6-45 6-41
- Inspection 6-45 6-41
- Installation 6-44 6-41
- Removal 6-44 6-41
- Repair 6-45 6-41

P

Pan, oil:
- Cleaning 6-46 6-43
- Inspection 6-46 6-43
- Installation 6-43 6-41
- Removal 6-43 6-41

Pistons:
- Cleaning 6-26 6-23
- Inspection 6-26 6-23
- Installation 6-28 6-25

Pump, oil:
- Cleaning 6-45 6-41
- Inspection 6-45 6-41
- Installation 6-44 6-41
- Removal 6-44 6-41
- Repair 6-45 6-41

R

Radiator 5-3 5-1

Rear axle:
- Cleaning 10-2 10-1
- General 10-1 10-1
- Inspection 10-2 10-1
- Installation 2-26 2-16

Paragraph Page

Rear axle - continued:
- **Removal** 2-26 2-16
- **Repair** 10-2 10-1

Rear springs:
- **Cleaning** 10-5 10-7
- **Inspection** 10-5 10-7
- **Installation** 2-26 2-16
- **Removal** 2-26 2-16

Reassembly:
- Alternator 3-4 3-1
- Axle, front 12-2 12-1
- Axle, rear 10-2 10-1
- Bearings, main 6-29 6-28
- Brakes 9-6 9-2
- Carburetor 4-4 4-3
- Cylinder head 6-14 6-13
- Distributor 3-8 3-10
- Engine 6-10 6-4
- Oil pump 6-45 6-41
- Propeller shaft 8-3 8-1
- Starter 3-6 3-6
- Steering gear 11-3 11-2
- Transmission: 7-12 7-11
  - Control valve body 7-13 7-17
  - Extension housing 7-16 7-22
  - Front clutch 7-23 7-28
  - Front pump 7-20 7-26
  - Front servo 7-14 7-20
  - Governor 7-17 7-23
  - Pressure regulator 7-18 7-24
  - Rear clutch 7-22 7-27
  - Rear pump 7-21 7-27
  - Rear servo 7-15 7-21
- Vacuum booster 9-9 9-8

Records, forms and 1-6 1-1

Refinishing cylinder walls 6-24 6-22

Removal:
- Axle, front 2-27 2-18
- Axle, rear 2-26 2-16
- Bearings, main 6-29 6-28
- Brakes 9-6 9-2
- Camshaft 6-39 6-38
- Crankshaft 6-29 6-28
- Engine 2-24 2-13
- Fuel tank 4-2 4-3
- Oil pan 6-43 6-41
- Oil pump 6-44 6-41
- Propeller shaft 8-2 8-1
- Steering gear 2-29 2-19
- Transmission 2-25 2-14
- Vacuum booster 2-28 2-19
- Valves 6-14 6-13

Repair:
- Alternator 3-4 3-1
- Axle, front 12-2 12-1
- Axle, rear 10-2 10-1
- Brakes 9-6 9-2
- Carburetor 4-4 4-3
- Cylinder head 6-16 6-15
- Distributor 3-8 3-10
- Fuel tank 4-2 4-3
- Oil pump 6-45 6-41
- Propeller shaft 8-3 8-1
- Starter 3-6 3-6
- Steering gear 11-3 11-2
- Tie rod 11-2 11-1

Paragraph Page

- Repair - continued:
  - Transmission: 7-12 7-11
    - Control valve body 7-13 7-17
    - Extension housing 7-16 7-22
    - Front clutch 7-23 7-28
    - Front pump 7-20 7-26
    - Governor 7-17 7-23
    - Pressure regulator 7-18 7-24
    - Rear clutch 7-22 7-27
    - Rear pump 7-21 7-27
    - Rear servo 7-15 7-21
  - Vacuum booster 9-9 9-8

S

- Starter:
  - General 3-5 3-6
  - Repair 3-6 3-6
- Steering gear:
  - Cleaning 11-3 11-2
  - Disassembly 11-3 11-2
  - Inspection 11-3 11-2
  - Installation 2-29 2-19
  - Reassembly 11-3 11-2
  - Removal 2-29 2-19
  - Repair 11-3 11-2

T

- Tie rod:
  - Cleaning 11-2 11-1
  - Inspection 11-2 11-1
  - Installation 11-2 11-1
  - Removal 11-2 11-1
- Tires 9-3 9-2
- Torque converter:
  - Cleaning 7-11 7-11
  - Inspection 7-11 7-11
  - Installation 7-11 7-11
  - Removal 7-11 7-11
- Transmission:
  - Adjustment 7-5 7-5

Paragraph Page

- Transmission - continued:
  - Air pressure checks 7-8 7-7
  - Component inspection 7-24 7-31
  - Control pressure check 7-7 7-6
  - Control valve body 7-13 7-17
  - Extension housing 7-16 7-22
  - Front clutch 7-23 7-28
  - Front pump 7-20 7-26
  - Front servo 7-14 7-20
  - Governor 7-17 7-23
  - Hydraulic control system 7-3 7-2
  - Installation 2-25 2-14
  - Leakage checks 7-9 7-8
  - Manual linkage 7-19 7-25
  - Pressure regulator 7-18 7-24
  - Rear clutch 7-22 7-27
  - Rear pump 7-21 7-27
  - Rear servo 7-15 7-21
  - Stall test 7-6 7-6
  - Torque converter 7-11 7-11

V

- Valves:
  - Cleaning 6-17 6-17
  - Inspection 6-17 6-17
  - Installation 6-21 6-20
  - Refacing 6-18 6-18
- Valve springs inspection 6-19 6-18

W

- Wheels:
  - General 9-1 9-1
  - Repair 9-4 9-2
- Wheel cylinders:
  - Cleaning 9-6 9-2
  - Inspection 9-6 9-2
  - Installation 9-6 9-2
  - Repair 9-6 9-2

By Order of the Secretary of the Army:

FRED C. WEYAND
General, United States Army,
Chief of Staff.

Official:
VERNE L. BOWERS
Major General, United States Army,
The Adjutant General.

Distribution:

To be distributed in accordance with DA Form 12-25B, (qty rqr block No. 487). Direct and General Support Maintenance requirements for Tractor, Wheeled: Light.

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CoA, 3d ENGINEER BN
FT. LEONARD WOOD MO 63108

DATE 16 DEC 74

PUBLICATION NUMBER TM5-6115-200-20 AND P	DATE 1 APR 72	TITLE GENERATOR SET 10 KW NSN 6115-00-231-7286

BE EXACT. . .PIN-POINT WHERE IT IS

PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:
6	2-1 a			In line 6 of paragraph 2-1a the manual states the engine has 6 cylinders. The engine on my set only has 4 cylinders. Change the manual to show 4 cylinders
81		4-3		Callout 16 on figure 4-3 is pointing at a bolt. In the key to fig. 4-3, item 16 is called a shim. Please correct one or the other.
125	line 20			I ordered a gasket, item 19 on figure B-16 by NSN 2910-00-762-3001. I got a gasket but it doesn't fit. Supply says I got what I ordered so the NSN is wrong. Please give me a good NSN

SAMPLE

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PAGE NO.	PARA-GRAPH	FIGURE NO.	TABLE NO.	

TYPED NAME, GRADE OR TITLE, AND TELEPHONE NUMBER	SIGN HERE:

.EAR ALONG DOTTED LINE

DA FORM 1 AUG 74 2028–2 *(TEST)*

P.S.––IF YOUR OUTFIT WANTS TO KNOW ABOUT YOUR MANUAL "FIND," MAKE A CARBON COPY OF THIS AND GIVE IT TO YOUR HEADQUARTERS.

FILL IN YOUR
UNIT'S ADDRESS

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DEPARTMENT OF THE ARMY

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OFFICIAL BUSINESS

Commander
U.S. Army Troop Support Command
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4300 Goodfellow Boulevard
St. Louis, Missouri 63120

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REVERSE OF DA FORM 2028-2 (TEST)

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